A Protocol for Testing, Assessing and Approving Innovative or Alternative Onsite Wastewater Disposal Systems

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Forward

This protocol is intended to provide a standardized approach for reviewing and approving Innovative and Alternative Onsite Wastewater Disposal Systems. The protocol is intended to be comprehensive and universal.

In order to accomplish the "comprehensive" goal, the protocol relies on a set of standard parameters that are believed sufficient to establish most, if not all, regulatory requirements for any type of component, for any State's onsite system regulations. Therefore, this protocol can be used to evaluate treatment systems, filters, or any number of other components or systems.

In order to accomplish the "universal" goal, technology is not "approved" in a wholesale manner. Instead, a two level system allows for a maximum degree of universality while maintaining a maximum degree of sovereignty for each review entity (State etc.). Universality is obtained by universal acceptance of the verification protocol. Allowing each entity to establish approvals that are based on the findings from the verification process level preserves sovereignty. Sovereignty is widely acknowledged to be necessary for the successful implementation of the protocol, since each domain has different regulations and "customs." For example, even if two states agreed that an innovative cesspool works as well or better than a typical cesspool, one state may not allow cesspools at all, so the innovative cesspool could not be approved any more readily than a standard one!

The protocol consist of two process levels:

- The verification and assessment level
- The approval level.

At the verification and assessment level, the vendor proposes a scientific study to validate a "claim" or hypothesis. The technology is tested against a specific list of parameters that can be associated with most regulatory requirements. After the study is complete, the results are assessed by one or more members of the Consortium of Review Entities (CORE), and a numerical or narrative "approved performance value" is assigned for the product on a nationally circulated database.

At the "approval" process level, a review entity utilizes a standardized procedure to establish approval(s) that are specifically relevant to the local domain or governing agency. This approval is accomplished by using a logical process that compares the verified "approved performance value" to a set of domain specific alternate requirements, which can be described as variances from the standard requirements.

The protocol is organized into three major parts. The first part provides guidance for vendors to follow. The second part provides guidance for the operators of the testing centers. The third part provides guidance for the review entities. Definitions and acronyms are provided in Appendix I and II. If you are a vendor, you will need to read and follow Part 1. If you are a review entity or a proxy for one, you will need to be familiar with Part 1 and Part 2 and Part 3.

Please contact Dr. Fred Bowers at fbowers@dep.state.nj.us or 609-292-0407 for more information or if you would like to help review the protocol as it is being finalized.

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Finally, for those who ultimately read this or intend to use it, this version should be considered a “work in progress." Once people start to use it, weaknesses will be discovered, and ultimately overcome by the anticipated involvement of a number of domain entities like States, counties, and the vendors. This version of the protocol should be thought of as a “first step.”

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Introduction

Background and Purpose of the Protocol

In the United States, onsite wastewater disposal technology has become fairly well developed and perfected, and is in widespread use throughout the country, particularly in rural or suburban areas. The most commonly employed method is typically referred to as a “septic system, but variants of this type of system are also used. Years of study and research have resulted in design standards that generally ensure that septic systems are protective of human health and the environment. Septic systems, when properly constructed, virtually eliminate outbreaks of diseases caused by human enteric pathogens such as those causing typhoid fever, cholera, dysentery, and impacts from viruses and protozoa or other parasitic organisms.

Elimination of disease is a great human achievement, but in recent years, many government agencies in the United States have begun to realize that widespread use of onsite wastewater disposal continues to cause other problems that are not addressed by existing technologies. For example, nitrate pollution is becoming a concern in many areas due to ground water impacts and its contribution to eutrophication of surface water from ground water baseflow. Furthermore, not all onsite wastewater disposal systems are constructed properly, and do not function as designed. In addition, standard designs are simply inadequate when difficult site limitations exist and pollution problems can result even when systems are constructed according to the standards. Because of this, governments have begun to look to new technologies that can help overcome difficult site constraints, and can reduce pollution in ways that will preserve the environment even as higher density human impacts put increased stresses on the land and water. In addition, entrepreneurs are constantly seeking new ways to market products that are more efficient to produce or install or that can overcome limitations or site constraints that conventional septic systems cannot achieve. For this reason, government regulatory agencies have recognized that more should be done to encourage the use of innovative and alternative systems or components.

On June 4, 1996 the heads of the state environmental agencies in California, Illinois, Massachusetts, New Jersey and Pennsylvania and New York signed a memorandum of understanding (MOU) to define a process for the reciprocal evaluation, acceptance and approval of environmental technologies among the six states. According to the six-state reciprocal MOU, the process would enable participating states to consider data, evaluations, verifications, certifications, approvals and permits from another participating state as if they had been produced in their respective states. To implement the reciprocity MOU, the six states selected eleven sample technologies for a pilot project evaluation of this process. The sample technologies included at least one technology of particular interest to each state and represent a full range of environmental technologies for pollution prevention, measurement and monitoring treatment and control and remediation. Through the pilot project, the six states identified common data evaluation; performance testing and regulatory review protocols for the pilot technologies and defined the most efficient acceptance and approval process for each technology class. The six states have now used the results of the pilot project to develop guidance for the use of technology developers, vendors, users and other states. These projects, however, have not yet included review of onsite wastewater technology.

The MOU initiated an effort in December 1999 by New Jersey, Massachusetts and Pennsylvania to develop a standard protocol for approving innovative and alternative technology for Onsite

Wastewater Disposal Systems. Since the initiation of that effort in 1999, Illinois and California have become participants in the process as well. Furthermore, discussions with other states and government entities has identified a need for a "universal" protocol that deals with this issue in a comprehensive manner that if possible, can be applied regionally or nationally. This document is the result of the effort to develop a "universal" protocol that any State or entity responsible for approving innovative and alternative technology systems can use, to the maximum extent possible, to approve the work done by others. This protocol has been developed to evaluate and verify the claims made by manufacturers of onsite wastewater systems and components that their products "work as well as or better than conventional systems or components."

The protocol follows a three tiered process that is the approach advocated by the first group of signatories of the 6 state MOU. First, Tier 1 provides general guidance on data collection and evaluation. Second, Tier 2 provides technology specific guidance for specific classes of technologies (like onsite wastewater disposal systems), and finally; Tier 3 provides guidance for permitting and approvals of certain technologies. The stated purpose of the three-tier approach is to:

- Reduce duplicative demonstration and testing of technologies;
- Expedite multi-state technology acceptance;
- Reduce cost for both vendors and state regulators.

The following are the objectives that apply in the three tier process:

- To verify performance of the technology with respect to a specified list of chemical, biological, and physical parameters, under a specified influent flow characteristics or patterns, using raw wastewater at the test site that is representative of "normal" domestic wastewater for selected key parameters
- To assess operation and maintenance considerations associated with the technology, including an evaluation of the performance and reliability of various components and measurement of the level of required operator attention, solids handling, and retention measures.
- To measure cost factors associated with the use of the technology
- Identify and assess environmental inputs and outputs (beyond effluent quality) including chemical usage, energy usage, generation of byproducts or residuals, noise, and odors.
- To establish and implement strict QA/QC methods and procedures during sampling, field and laboratory analyses, and data handling (data recording, calibration, reduction, evaluation and reporting)
- To assess additional claims by the Vendor, as described in the Test Plan, with respect to the technology performance

Overview of the Protocol

Technology Covered by this Protocol

This protocol has been developed to evaluate technologies and components that are involved in onsite treatment of domestic wastewater from individual homes[1]. Onsite wastewater disposal systems consist of four major component classes, and each component class consists of subclass components. The major classes are:

[1] A system can be scaled up to meet demands of different wastewater sources or volumes but should be done with caution.

- Pre-treatment Components
- Distribution Components
- Final Treatment Components
- Accessories

Examples of the component subclasses are listed in Table 5.

Fundamental Premises underlying this Protocol

Most review entities (government agencies that regulate onsite wastewater treatment systems) have regulations that pertain to the design of onsite wastewater treatment systems. Often these standards are based on a combination of experimental and empirical science, EPA guidance, and good old-fashioned custom and experience. In other words, sometimes the regulations simply express designs for systems that the authorities believe will "work", and they continue to be used without too much scrutiny because experience suggests that they do "work." This condition has served the nation well in the past, but it leads to problems when someone wants to obtain an approval to use a novel product that is not already allowed under the currently practiced regulatory framework. The problems occur because in many cases, the rationale for deriving the regulatory requirements is lost or not clearly expressed in the rule or in the underlying rule proposal documentation. In other words, often it is not clear what it means when we say that a technology "works." The reason underlying this disconnection is that there is no clear set of standard parameters that are used to evaluate products and subsequently establish requirements. Consequently, when a new technology is proposed, it is not easy to compare the product against a set of performance standards because there is no clear linkage of a standard to the provisions of the regulations. When these "missing linkages" occur it is difficult to reconstruct the rational process that resulted in the regulatory requirements in the first place. This necessitates a "reverse engineering" process whereby the system or regulations is known, but the underlying purpose of the parts and/or requirements is not clearly tied to an environmental or health based standard. Not all States or domains will have this problem, but this protocol is designed to be universal, so it considers this possibility. Therefore, the principles are established to enable any domain to review and approve technology, based on the simple concept that a rational set of parameters can be used to determine onsite wastewater regulations that effect human health and the environment. If a domain or review entity has a set of regulations that does not have "missing linkages," it will simply be easier for them to ultimately approve technology that has been assessed using this protocol.

This Protocol is predicated on the concept that if the performance standards are known, or at least the standard parameters are known, it is possible to apply a rational process to evaluate a product against the standards, then to determine how the product can be used to function as a surrogate or supplement to products that are allowed in the regulations.

This Protocol follows a model that is based on the following premises:

1. Every requirement in a regulation is based on a human health or environmental standard or goal.
2. There are a limited number of standard parameters that underlie the requirements in the regulations.
3. If the standard parameters are identified on a list, products can be evaluated to see how they perform with respect to these parameters.

4. Once the performance of a product is known, it is possible to establish how a product can be used as a surrogate or supplement to materials and systems that are identified in the regulations.

Conceptual Framework of the Protocol

This protocol encompasses both "Tier 2" and "Tier 3" levels. The conceptual process for approving innovative or alternative technologies where they apply to onsite wastewater disposal is depicted in the flow chart in Figure 1 below. In Short, the protocol is divided into two process levels:

1. Verification and Assessment Level (Tier 2)
2. Approval Level (Tier 3)

The verification level consists of three parts. First a vendor develops a proposal to conduct a scientific study that is intended to verify the particular product claims. Second, a designated person or group conducts the verification program and develops a report. Third, a designated review entity or proxy conducts an assessment of the result of the study and adds a validated fact to a "Product Performance Table."

The approval level consists of a process where the Review entity utilizes a standardized procedure to establish the approval(s) that are specifically relevant to the local (domain) government. This approval is accomplished by using a logical process that compares the verified performance criteria to a set of standards. This process can be further simplified by creating and using a computerized "Database Management System" (DBMS), but at first, the process will be conducted manually. A prototype of the DBMS is provided Appendix 3: The Database Management System Design Specifications

Using the protocol, the technology is not "approved" in a wholesale manner. Instead, the two level system allows for a maximum degree of "universality" while maintaining a maximum degree of sovereignty for the review entity (State etc.). Universality is obtained by universal acceptance of the **verification level** of the protocol. Sovereignty is preserved by allowing each entity to establish approvals at the **approval level** that are based on the findings from the verification level, but that are specific to the rules and customs of the domain. This two level approach is considered to be necessary to the success of this attempt at a universal system, since it is nearly impossible for any two review entities to agree on the specified details of how a technology can be used to overcome particular regulatory constraints. For example, even if two states agreed that an innovative cesspool works as well or better than a typical cesspool, one state may not allow cesspools at all, so the innovative cesspool could not be approved any more readily than a standard one!

Responsible Parties and Roles

The principal parties involved in evaluating an innovative or alternative onsite wastewater technology under this protocol may include the following:

- A Vendor or Applicant
- A Review Entity or Consortium of Review Entities
- A Verification Center or Testing Organization

The responsibilities of each party are presented in the following sub-sections.

Responsibility of a Vendor

The Vendor shall have the following responsibilities:

- initiates the application for testing;
- selects the Testing Organization from a list certified by the consortium of review entities;
- prepares the Innovative and alternative Technology Verification (ITV) proposal (Part 1);
- selects a proposed test site or willingness to use a certified center;
- willingness to conduct the ITV program in accordance with approved proposal and any conditions set forth therein by the review entities.
- provides complete, field-ready equipment ready for delivery) and the operations and maintenance (O&M) manual(s) typically provided with the technology (including instructions on installation, start-up, operation and maintenance) for verification testing;
- provides existing relevant performance data for the wastewater treatment technology if it has been tested/operated at other locations;
- provides logistical and technical support as required;
- pays for the testing;
- provides assistance to the Testing Organization on the operation and monitoring of the equipment during the verification testing on an "as needed" basis; and,
- willingness to review and comment on the site-specific Test Plan when approved by the review entities.

Responsibility of the Review Entity or Consortium of Review Entities

The review entity consists of the agency of government (or proxy reviewer) authorized to review and approve alternate technology for a specified domain (geographic area or governmental unit (state, county, municipality etc.) for which a technology is intended to be used). A number of review entities may collaborate and form a "Consortium of Review Entities" if they agree to accept the Tier 2 protocol. The review entities should select of appoint a Technology Panel consisting of a group of individuals with expertise and knowledge in wastewater treatment technologies. The Panel will assist the Verification Organization in reviewing and commenting on the site specific Test Plan. An advisory group can also be appointed from the consortium of review entities (CORE) that will assist the Verification Organization in the approval of the Verification Report.

Responsibility of a Testing Center and/or Verification Organization

The Testing Organization can be a review entity; a separate center such as NSF one of the National Demonstration sites, or another center approved by CORE. Certified testing centers will be made available on a public list. A preliminary list of centers is in Table 13.

The Testing Center shall have the following responsibilities:

- willingness to conduct verification testing, according to the Test Plan;
- operation and maintenance of the wastewater treatment technology equipment in accordance with the Vendor's O&M manual(s);
- controlling access to the area where verification testing is being carried out;
- maintaining safe conditions at the test site for the health and safety of all personnel involved with verification testing;
- scheduling and coordinating all the activities of all verification testing participants, including establishing a communication network and providing logistical and technical support on an "as needed" basis;
- managing, evaluating, interpreting and reporting on data generated by verification testing; and,

- evaluation and reporting on the performance of the equipment.
- approval of test sites;
- reviewing and commenting on the site specific Test Plan;
- carrying out an on-site audit of test procedures;
- reviewing, commenting on and disseminating the Verification Report;
- approving the Verification Report in conjunction with the CORE; and,
- preparation and the dissemination of the Verification Assessment.

Summary of the Protocol

The protocol can be summarized as follows:

1. This Protocol and the included guidance documents can be collectively endorsed by any Review Entity responsible for approving onsite wastewater technology. Each Review Entity who endorses the Protocol becomes a member of a *Consortium of Review Entities (CORE).* The review entity is typically a State government agency or other domain. New members can join the CORE at any time by endorsing the Protocol.

2. A vendor for an approval must contact a Review Entity and must submit a proposal for review.

3. The vendor's proposal must include a clear statement of a hypothesis or a claim that vendor is attempting to achieve, demonstrate, and verify, and an experimental design that will be used to test the claim or hypotheses or to prove that the standard is achieved.

4. The review entity reviews the proposal and either approves or suggests modification. At this stage, a review entity can solicit peer review from other review entities.

5. After the proposal is accepted, the vendor for an Innovative and alternative Technology approval performs the study in accordance with the approved proposal. Alternatively, if a Review Entity accepts a proxy reviewer the verification will be handled by that entity.

6. After the study is complete, the vendor or proxy reviewer develops a report in accordance with the guidance.

7. The Review Entity or proxy reviews the final report, and responds with an Assessment. The results of the assessment are published in a manner that is accessible to all members of CORE.

8. The Review Entity conducts the Technology Approval process in accordance with this Protocol for their State or other domain.

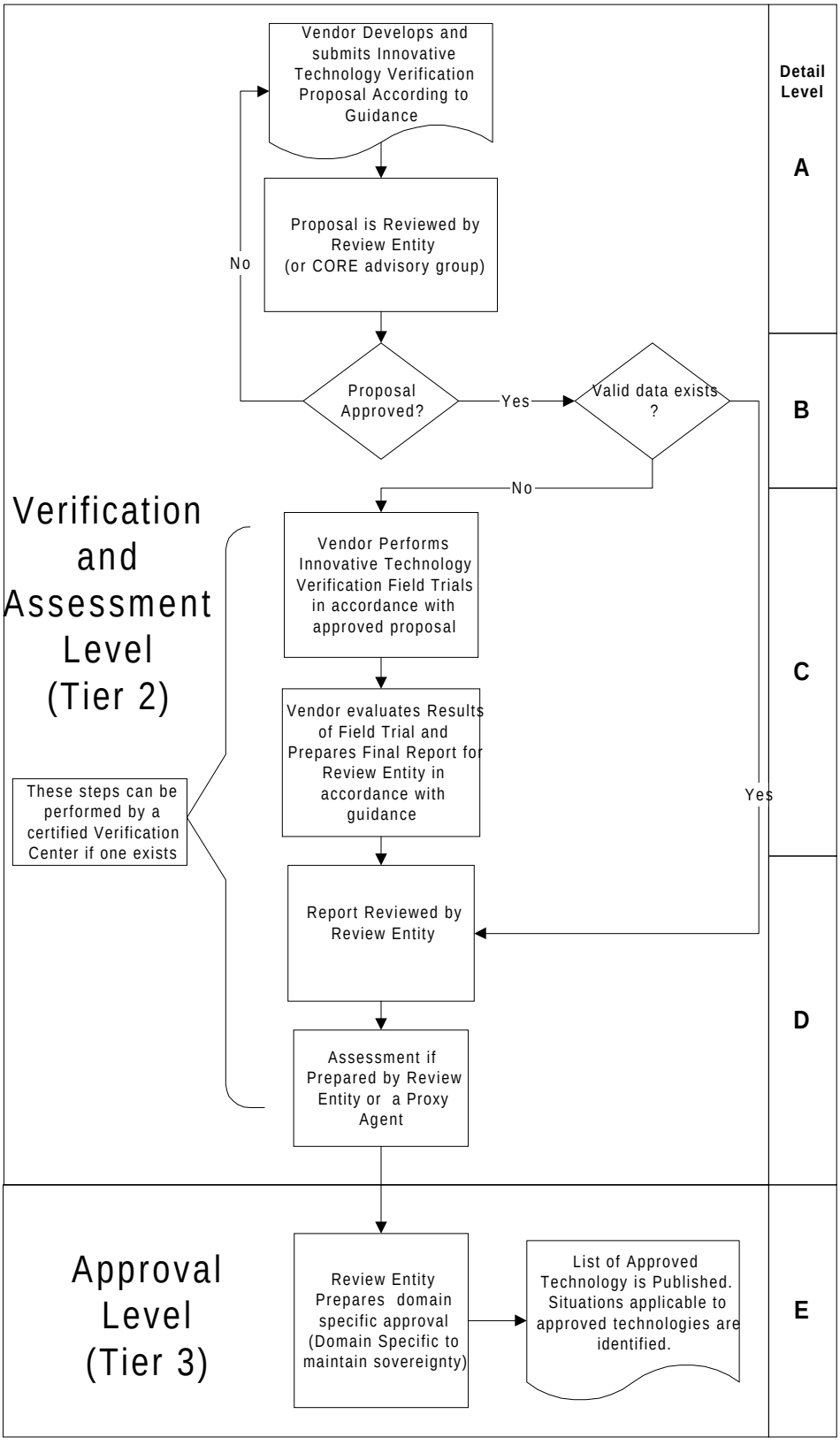

Figure 1. Simplified Process flow chart describing the Tier 2 and Tier 3 protocol for Innovative and alternative Technology Approvals for onsite wastewater treatment systems and components. The details are portrayed in the Figures for Process levels A through E.

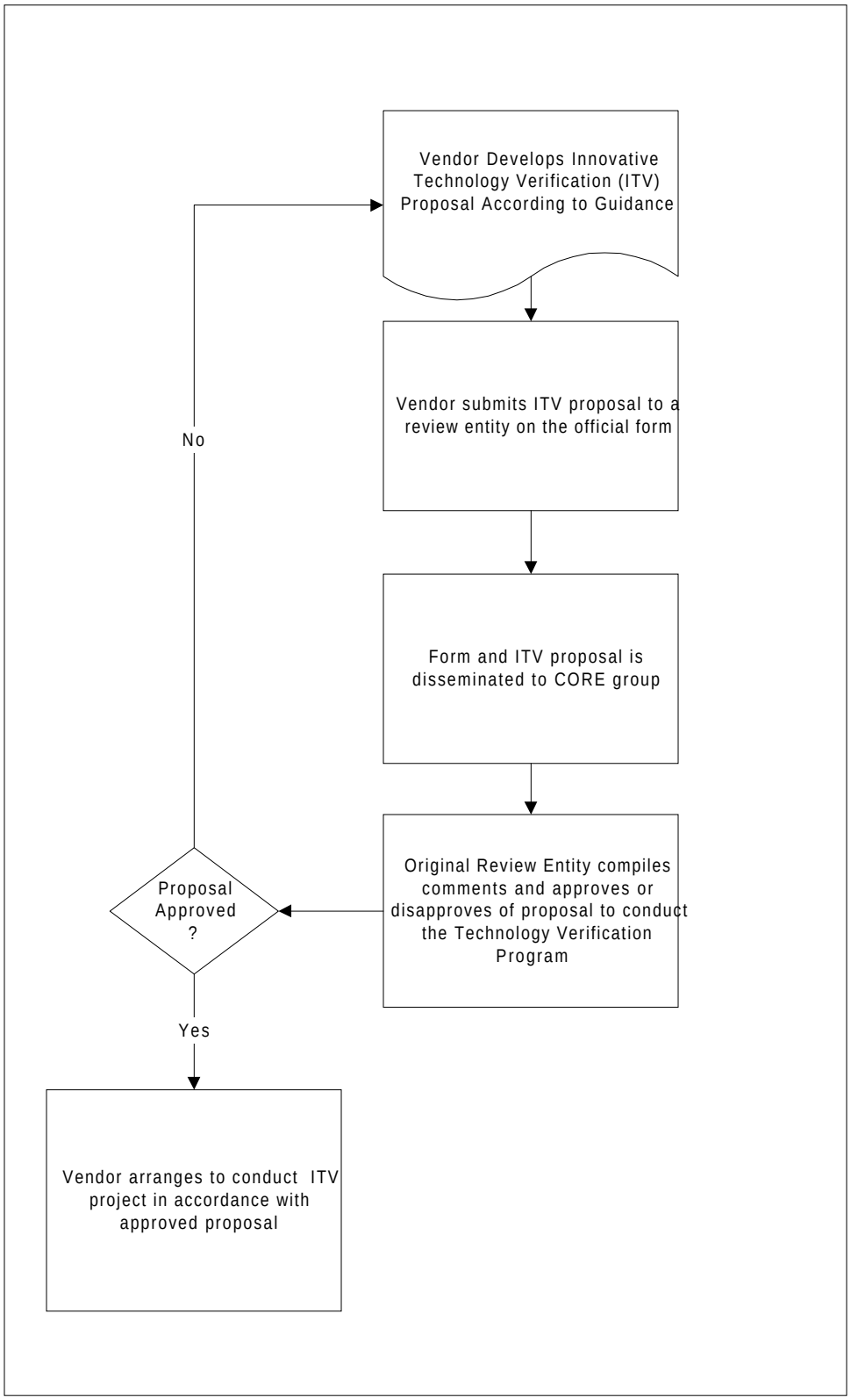

Figure 2. Detail A. Application Process flow chart

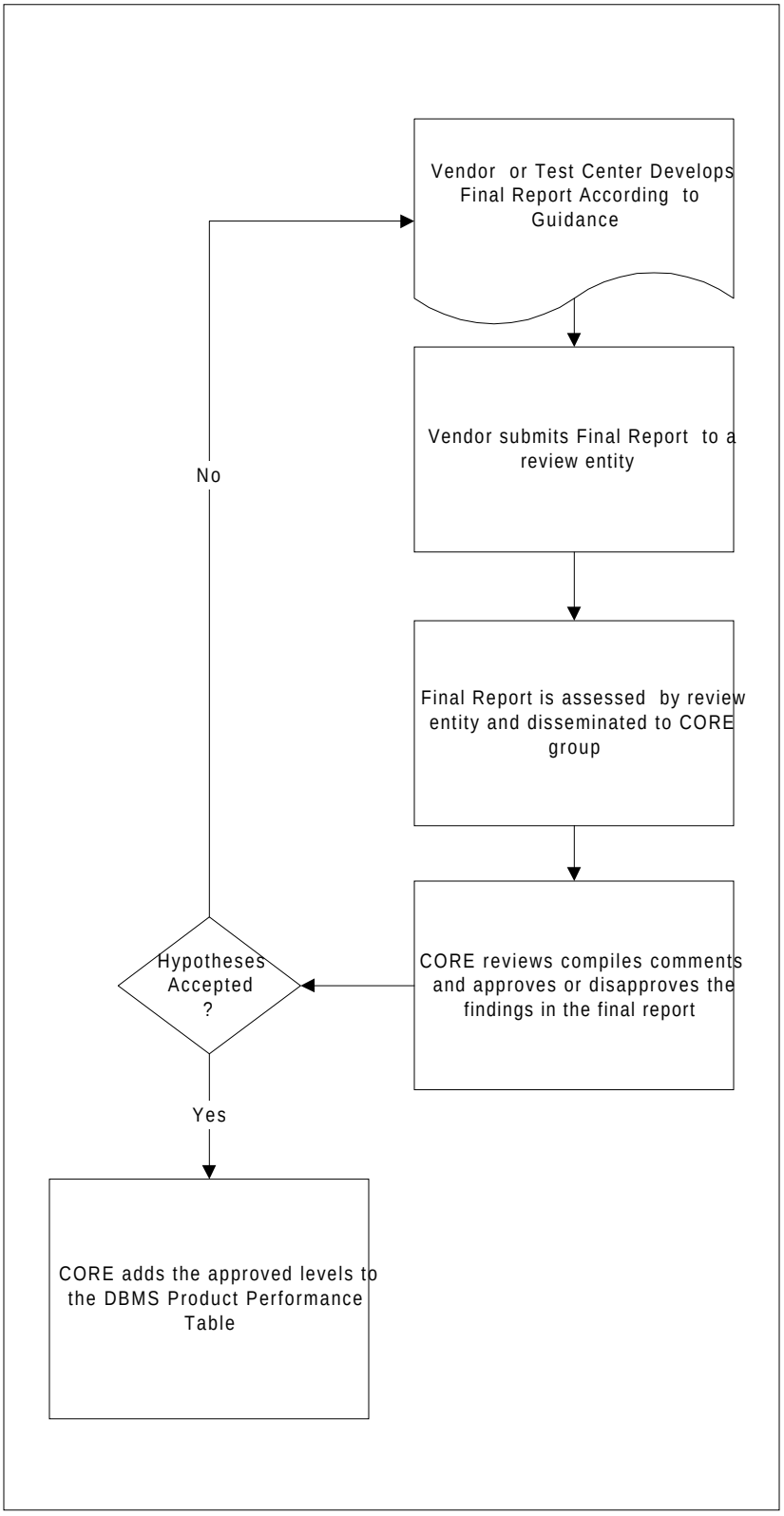

Figure 3 Review and approval flow chart

Developing the Innovative and alternative Technology Verification Program Proposal

The first step of the application process for an Innovative or Alternative Technology Verification Approval (IATV) occurs when a vendor submits a Test Plan proposal to a review entity following the guidance stated below. A detailed Test Plan shall be developed for every technology to be evaluated according to this protocol. The proposal shall follow, to the extent possible, the format stated in this guidance document. After a Review Entity receives a, proposal, it will be reviewed in accordance with Part 2 of this Protocol. Once reviewed, and if approved, the vendor will be notified how to proceed to conduct the verification program.

The Vendor shall provide at least the following items in the Test Plan:

- A brief statement of the technology system describing all components and process units and any water quality treatment objectives (what are the target nutrients);
- A statement of the technology's performance capabilities;
- Equipment and process description; Separate discussion for each type of component:
  - Pre-treatment Components
  - Distribution Components (Pipes, conveyances, distribution boxes, controls, and valves)
  - Final Treatment Components (soil zone contact with effluent (biomat, cation exchange, soil filtration, synthetic treatment media, etc.)
  - Accessories
- A brief statement of the Test Plan objectives;
- Operation and maintenance (O&M) manual(s); and
- Health and safety information relating to the equipment and the process.
- Instructions for component handling, transport, installation, and pre-operational testing

The Standard Format of the Test Plans shall include the following sections, in addition to other sections specified by the CORE for the evaluation:

- Title Page
- Table Of Contents
- Summary
- Abbreviations and Acronyms
- General Description of the Technology
- Goals and objectives of the Verification Project
- Experimental Method to be employed in the Verification Program
- Site, Operations, and Maintenance Considerations
- The Health and safety plan
- Schedule of deliverables

The detailed contents of this outline are explained below. A fully developed outline is included in Appendix 8.

General Description of the Technology

The vendor should provide, in a high degree of detail, a description of the technology, its purpose, and its basic method of functioning. This part of the proposal enables the vendor to express the particular benefit that may be obtained by receiving an approval. For example, a vendor could claim that a component or system will treat domestic wastewater so that nitrogen loading is reduced by 50% compared to a conventional septic tank.

The proposal shall include a discussion of the status of the development and commercialization of the technology should be described in the following general terms:

- pilot or bench scale
- treatability studies

When describing onsite wastewater technology and its purpose, systems should be generally considered to consist of four sub-systems. They are:

- Pre-Treatment sub-system (septic tanks, Aerobic Treatment Units, etc)
- Conveyance sub-system (pipes, chambers, distribution boxes, gravel)
- Final Treatment sub-system (soils, synthetic filter media, zone of treatment, zone of disposal)
- Accessories

Intended Benefit

The vendor shall provide a statement regarding the benefit that the technology is intended to accomplish or the environmental constraint that is intended to overcome. The vendor shall also identify if it is simply a variation of an existing technology.

Components

Each component of the system shall be described in detail. The purpose of each component shall be adequately identified. Description of the components shall be identified as sub-classes of one of the four major classes of components (Table 5).

Technology Cost

The vendor shall provide an estimate of the final cost of the technology to the consumer. This information will be useful to domains that may need to follow up by making regulatory changes that must be justified with regard to cost.

Regulatory Challenges

Discuss any regulatory challenges to overcome in the applicable State or domains if they are known. Discuss how this study will help overcome these challenges.

Existing Approvals from other states

Discuss any existing approvals including restrictions or limitations from other States or domains.

Proprietary Issues

The Test Plan shall identify proprietary concerns relative to the Vendor's technology and discuss how they will be addressed during the course of verification testing and reporting.

Goals and objectives of the Verification Project

The proposal must include a clear and unambiguous statement of the goals and objectives for the verification project. The discussion should emphasize how the verification project will prove that the technology will accomplish the intended use.

The goals of the field verification should be clearly and concisely defined. The goals should be specific and be described in quantitative terms to the extent possible. The goals should establish what the verification would be sampling and analyzing, the data that will be generated, how it will be evaluated and the performance of the technology to be evaluated.

Experimental Method to be employed in the Verification Program

This protocol relies on the vendor to discuss in detail the scientific method that will be used to substantiate any claims or conclusion that the technology will accomplish the stated environmental goals. This protocol relies on the vendor to adhere to strict conventional scientific methods of analysis.

- State Hypothesis or claims
- Conduct an experiment to test the hypotheses
- Validate the results of the and render conclusions regarding the null hypothesis
- Redo the experiment or obtain an approved performance value from CORE

In keeping with the scientific method approach, the vendor shall make a clear statement for each claim. For example, "This product will pre-treat domestic wastewater such that it will discharge at 10 mg/L 95% of the time." This is the *hypothesis* that will be tested. The parameters for which claims can be made are listed in Table 4. If a vendor believes a parameter other than those listed in Table 4 is appropriate, he shall propose to include this new parameter with sufficient justification. If the CORE agrees to include this parameter, it will be added to the table and the vendor can then derive hypotheses using it.

If the treatment process involves multiple stages, it may be appropriate to collect samples at intermediate points. The Test Plan shall clearly indicate the sampling points for the technology being evaluated.

If the Vendor does not intend to seek verification with respect to reduction of a certain nutrient, then the parameter list and subsequent Verification Report and Statement can be adjusted accordingly. The Vendor may also seek verification with respect to parameters not listed in Table 4, but addtional parameters that will be tested must be proposed for approval by CORE prior to initiating any tests. If the parameter is determined to be a valid and relevant one, it will be added to the Table 4 list by CORE.

In order to simplify the review process, a list of claims or hypotheses shall be complied on a form such as provided in Table 14.

Collecting and Maintaining Descriptive Data

Descriptive data are basic facts regarding the nature of the site or facility. Typically, these data are invariant during the course of the experiment. Descriptive data are site location, geology, soils, climate and other such facts.

Systems and/or Component Plans and Cross Sections

The systems or components shall be described using detailed and accurate scale drawings and plans. These drawings shall be created using standard mechanical drawing principles and shall be

provided to the review entity in a format appropriate to the size and scale of the system or components. Additional versions of the plans shall be presented either on computer disk format in AutoCAD© or a compatible program, or shall be included on 8.5 x 17 inch paper, capable of photocopying.

When a system is being described, it shall be considered on the basis of the concept that a complete onsite wastewater treatment system consists of four functional classes of parts (Component Classes) for purposes of developing the verification testing procedure, as discussed previously. These are:

1. The Pre-treatment Components (Septic tank, aerobic tanks etc.)
2. The Conveyance or Accessory Components
3. The Final Treatment Components
4. Accessories

Each part shall be identified in the drawings and plans. Each part shall be considered individually when doing the research, so that the review entity can determine at what point in the system the major benefits are derived.

All plans should be sealed by a licensed Professional Engineer in order to ensure that each review entity will be able to accept the work, regardless of the particular requirements of each entity.

Site Descriptions and Maps

Most verification projects will be managed at a physical location. The site description, at a minimum, will consist of narrative descriptions and maps. The purpose is to describe where the site is located, and how to get there.

Maps and scale drawings shall be provided for all sites used in the verification projects. At a minimum, the following maps shall be included.

A State map

The State map shall be drawn to fit on an 8.5 X 17 inch page, that shows the location of the study site in reference to the State in which the verification program is managed.

A topographic map(s):

The topographic map of the facility shall be presented in the proposal. It shall have a horizontal scale of at least one inch equals 200 feet and a contour interval of five feet. The map shall be a U.S. Geological Survey 7.5 minute series Topographic Quadrangle. The quadrangle shall be the most recent revision. Contour elevations shall be based on established United States Geological Survey Control Datum.

A Ten Mile Radius Map

The site shall be shown relative to the road system in a manner that enables a person to find the site or to visit the site by motor vehicle. This can be referred to as a “field routing map.”

A Detailed Site Plan

A site plan drawn to a scale shall show legal boundaries. The site plant shall be surveyed by licensed land surveyor and shall indicate roadways and adjacent property ownership.

Soils Data

When soils are employed as a component of the in the verification project, for example in final treatment, they shall be described using standard USDA protocols. The qualifications of the soil evaluator shall be provided. At a minimum, these descriptions shall consist of measured or described data as follows:

Soil profile Description

The soil profile description shall be provided using USDA protocol for describing soils.

Soil chemical and physical properties

- Description of particles >2mm. For example, the description shall estimate the percent of cobbles, rocks, pebbles, etc. and their shape and petrologic makeup.
- A Particle size analysis shall be implemented that identifies the proportions of sand, silt, and clay
  - A Grain size distribution evaluation shall be completed using a set of sieves that enables an assessment of the various sand size particles as follows in Table 1.
  - Silt and clay fractions shall be determined by hydrometer or pipette method and the results shall be tabulated and/or graphically displayed.
- Soil chemical properties data including
  - Organic matter content
  - TKN plus Total Nitrate nitrogen
  - pH (in distilled water and KCL)
  - Cation Exchange Capacity (CEC) using a neutral salt method (i.e. KCL)
  - Any other chemistry data if relevant to the ultimate findings and conclusions of the study

Table 1 Particle size fractions in the sand size range as determined by sieve analysis.

Particle Size Class	Size (mm)
Very coarse sand	2-1
Coarse Sand	1-0.5
Medium Sand	0.5-0.25
Fine Sand	0.25-0.1
Very Fine Sand	0.1-0.05

Weather

If the experiment takes place outside, weather data shall be collected daily and maintained according to the format specified in the proposal.

Collecting and Maintaining Experimental Data

Requirements applicable to all studies

Maintaining an experimental log book

An experimental log book shall be maintained onsite and shall be available for review by the review entity. It shall include daily observations and descriptions of the conditions associated with the experiment, and shall include any facts regarding problems or details of the progress/process of the study.

Handling Raw data

All raw data shall be provided on a spreadsheet format (Microsoft Excel or another acceptable database format). No data shall be censored; all shall be provided.

Rendering data and deriving descriptive Statistics

Descriptive statistics shall be rendered from the raw data. These statistics shall include the following, at a minimum.

- Number of samples (n)
- Average or Sample Mean ($\overline{X}$)
- Maximum Value (Max)
- Minimum value (Min)
- Median Value (50% percentile) Other quantiles (25%; 75%, 99%) or a percentile graph will be useful in some cases.
- Sample Standard Deviation or sample variance (Std)
- Presentation of data that characterizes the central tendency at different times (eg. 30 day moving averages).

Statistical Analyses

The report shall discuss the distribution characteristics of the data and determination of deviation from Normal (Gaussian) distribution shall be determined using Probability Graph Paper or the Kolmogorov-Smirnov Test of normalcy (or other acceptable alternative). All comparisons and tests for statistical significance shall be conducted using a test appropriate to the distribution of the data.

- Non-parametric data shall be subjected to non-parametric tests.
  Mann-Whitney U test
  Kruskal-Walace H Test
  Sign Test
  Other tests as appropriate
- Parametric data shall be submitted to parametric tests such as:
  Student t-test
  ANOVA
  Confidence intervals
  Other tests as appropriate

Additional Performance Evaluations

Alarm Systems

The advanced treatment technology may incorporate certain alarm systems to alert the property owner and/or operator of equipment failure, high liquid level, etc. During the evaluation period, any alarm systems associated with the technology shall be operationally tested and verified at least once per month. The Test Plan shall describe the means by which alarm systems are to be evaluated.

Other

The Vendor may have additional claims relative to the performance or functioning of the technology to be evaluated during the test period. The Test Plan shall specifically address the means by which additional claims will be verified.

Quality Assurance / Quality Control (QA/QC)

QA/QC Objectives

Quality assurance and quality control of the equipment calibration, equipment operation, process maintenance, and the measured water quality parameters shall be maintained throughout the verification testing program. The Testing Organization shall prepare a Quality Assurance Project Plan (QAPP) for the Verification Testing, to be included in the Test Plan, that specifies procedures to be followed to ensure the validity of test results and their use as the basis for equipment performance verification.

The QAPP applies to all organizations involved in the Equipment Verification Testing, including Testing Organizations and laboratories qualified by the Verification Organization. The Testing Organization shall have the primary responsibility for ensuring that all individuals involved in the Equipment Verification Testing comply with QA/QC procedures during the course of verification testing, although the Verification Organization shall qualify the Testing Organization and laboratories prior to initiation of testing.

The objective of QA/QC is to ensure that strict methods and procedures are followed during testing so that the data obtained are valid for use in the verification of a technology according to this protocol. In addition, QA/QC ensures that the conditions under which data is obtained will be properly recorded so as to be directly linked to the data, should a question arise as to its validity.

The following QA/QC measures shall be addressed in the QAPP:

- Description of methodology for measurement of accuracy;
- Description of methodology for measurement of precision;
- Description of the methodology for use of blanks, the materials used, the frequency, the criteria for acceptable method blanks and the actions to be taken if criteria are not met;
- Description of any specific procedures appropriate to the analysis of the performance evaluation samples. It has to be clear how these samples are going to be used in the verification testing;
- Outline of the procedure for determining samples to be analyzed in duplicate, the frequency and approximate number;
- Description of the procedures used to assure that the data are correct;
- Definition of data to be reported during the verification testing, in terms of analytical parameter type and frequency;
- Listing of techniques an/or equations used to quantify any necessary data quality indicator calculations in the analysis of water quality parameters, microbiological contaminants or operational conditions (e.g., flow rates, mixer speeds, detention times);
- Outline of the frequency, format, and content of self-assessments of the Testing Organization’s technical systems;

- Outline of the frequency, format, and content of assessment reports to the Verification Organization;
- Development of a corrective action plan responding to audit findings;
- Requirement to provide all QC information, such as calibrations, blanks and reference samples, in an appendix to the report. All raw data shall also be reported in an appendix;

Intended Uses of Acquired Data

The intended uses of the data acquired under this protocol shall determine the amount of data and the parameters of concern.

Analytical Quality Levels and Quality Control Levels

Whether the quality assurance (QA) objectives for the project, as outlined in the QAPP, are met will be determined through the use of quality control (QC) elements assessing precision, accuracy, representativeness, completeness and comparability. Each of the QC elements is discussed in the following section.

Quality Control Indicators

Precision

Precision is defined as the degree of mutual agreement relative to individual measurements of a particular sample. As such, Precision provides an estimate of random error. Precision is evaluated using analysis of field or matrix spiked duplicates. Method precision is demonstrated through the reproducibility of the analytical results. Relative percent difference (RPD) may be used to evaluate Precision by the following formula:

$$RPD=[(C_1- C_2) \div ((C_1 + C_2)/2)] \times 100\%$$

Where:

C_1= Concentration of the compound or element in the sample

C_2= Concentration of the compound or element in the duplicate

The Test Plan shall present the precision methods to be employed in the analysis of data generated under the Verification Testing Program.

Accuracy

For water quality analyses, accuracy is defined as the difference between the measured or calculated sample result and the true value for the sample. The closer the numerical value of the measurement comes to the true value or actual concentration, the more accurate the measurement. Loss of accuracy can be caused by errors in standards preparation, equipment calibrations, interferences, and systematic or carryover contamination from one sample to the next.

Analytical accuracy may be expressed as the percent recovery of a compound or element that has been added to a sample at known concentrations prior to analysis. The following equation is used to calculate percent recovery:

$$\text{Percent Recovery}=(A_r-A_o)/A_f \times 100\%$$

Where:

A_r= Total amount detected in spiked sample

A_o= Amount detected in unspiked sample
A_f= Spike amount added to sample.

Accuracy will be ensured in technology evaluation by maintaining consistent sample collection procedures, including sample locations, sample timing, sample handling, and by executing random spiking procedures for specific target constituent(s). The Test Plan shall discuss methods to determine the accuracy of sampling and analyses.

For equipment operating parameters, accuracy refers to the difference between the reported operating condition and the actual operating condition. For operating data, accuracy entails collecting a sufficient quantity of data during operation to be able to detect a change in system operations. As an example, accuracy of flowrate may be the difference between the flow indicated by a flow meter and the flow measured on the basis of volume over time (with a container of known volume and a stopwatch). Meters and gauges shall be checked periodically for accuracy. The Test Plan shall discuss means for determining the accuracy of equipment operating parameters.

Representativeness

Representativeness is the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. Representativeness is a qualitative parameter relating to the proper design of a sampling program. The Test Plan shall describe the means by which the representativeness of samples collected during the technology evaluation will be ensured.

Completeness

Completeness is expressed as the percentage of valid, acceptable data obtained from a measurement process compared to the minimum amount that was needed to draw an accurate conclusion. The Test Plan shall specify the minimum amount of data needed for each of the various testing stages (start-up period, sampling, stress testing, etc.); however, that amount shall not be less that that provided in this protocol.

Comparability

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another. Analytical results are comparable to results from other laboratories as a result of participation in procedures/programs such as the following: use of instrument standards traceable to National Institute of Standards & Technology (NIST) or EPA sources; use of standard or validated methodology; reporting of results in consistent units; and participation, as appropriate, in inter-laboratory studies to document laboratory performance. By using traceable standards and validated methods, the analytical results can be compared to other laboratories operating similarly. The Test Plan shall describe the means by which the comparability of data sets generated during the technology evaluation will be ensured.

Water Quality and Operational Control Checks

Quality control checks provide a means of measuring the quality of the data obtained. This section describes quality control checks for both water quality analyses and equipment operation. The Testing Organization may not need to use all of the checks identified in this section. The selection of appropriate quality control checks depends on the equipment, the experimental design, and the performance goals. The quality control checks to be used in the evaluation of a

technology shall be specified in the Test Plan, in addition to discussion of the corrective action to be taken if the quality control parameters fall outside of the evaluation criteria.

Water Quality Data

Following the start up period, the results of the treatment achieved by the advanced treatment technology being evaluated are interpreted in terms of water quality. Thus, the quality of the sampling and analysis is important. The QAPP shall emphasize methods to be employed for sampling and analysis QA/QC. Some important aspects to be considered are the following:

Spiked Samples

The use of spiked samples will depend on the testing program and the target contaminants. If spiked samples are to be used, the Test Plan shall specify the procedures, frequency, acceptance criteria, and actions if criteria are not met.

Method Blanks

Method blanks are analyzed for selected water quality parameters to evaluate analytical method-induced contamination, which could cause false-positive results. The Test Plan shall identify the need and procedures for method blanks.

Travel Blanks

Travel blanks shall be provided to the analytical laboratory to evaluate travel-related contamination. The frequency and evaluation of travel blanks shall be specified in the Test Plan.

Field Duplicate Samples

A field duplicate sample is a second sample collected at the same location as the original sample. Duplicate sample results are used to assess precision, including variability associated with both the laboratory analysis and the sample collection process. Duplicate samples are collected simultaneously or in immediate succession, using identical recovery techniques, and treated in an identical manner during storage, transportation, and analysis.

The procedure for determining samples to be analyzed in duplicate shall be provided in the Test Plan, with the required frequency of analysis and the approximate number. The Test Plan should also discuss the number of duplicate samples to be provided to the laboratory as "blind duplicates".

Performance Evaluation Samples

Performance evaluation (PE) samples are samples whose composition is unknown to the analyst. PE samples are submitted with statistics about each sample that have been derived from the analysis of the sample by a number of laboratories using EPA-approved methods. These statistics include a true value of the PE sample, a mean of the laboratory results obtained from the analysis of the PE sample, and an acceptance range for sample values. PE samples shall be analyzed for selected water quality parameters before the analytical laboratory initiates technology evaluation. Control limits for PE samples will be used to evaluate the method performance of the analytical laboratory. An analytical laboratory that does not meet the control limits shall not be used for verification analyses.

Quality Control for Equipment Operation

The Test Plan shall explain the methods used to check the accuracy of equipment operating parameters and the frequency at which these checks will be performed.

All sampling and analytical instruments to be used at the local test site (i.e., DO meters, dosing system, sampler, etc.) shall be maintained and calibrated by trained test site personnel in accordance with manufacturer's instructions.

Corrective Actions

Each Test Plan shall include a corrective action plan. This plan shall include the predetermined acceptance limits, the corrective action to be initiated whenever such acceptance criteria are not met, and the names of the individuals responsible for implementation. Routine corrective action may result from common monitoring activities, such as:

- Performance evaluation audits
- Technical systems audits

Ultimately, responsibility for project quality assurance/quality control (QA/QC) during implementation of this protocol rests with the Verification Organization, specifically the Verification Organization Project Manager, with appropriate input from the Verification Organization QA/QC Manager. However, immediate QA/QC for individual tasks (e.g. sample collection, handling, preparation, and analysis) rests with the individuals and organization performing the task at hand, as described in this chapter throughout the protocol. The Verification Organization Project Manager will coordinate oversight and/or audits of these tasks with the Testing Organization Project Manager to ensure that the Test Plan is being executed as written, and that nonconformance is appropriately reported and documented.

Corrective action shall be taken whenever a nonconformance with the Test Plan occurs. Nonconformance can occur within the realm of sampling procedures, sample receipt, sample storage, sample analysis, data reporting, and computations.

Maintaining Weather and precipitation data

An accurate record of the weather shall be maintained during the entire period of the study. The measurements shall be obtained form onsite observations using high quality weather recording devices, or may be obtained from a local representative nearby site that is managed by a qualified scientific entity. The data shall include outside temperature, precipitation quantity and type, etc.

Requirements applicable to pretreatment system studies

Characterizing Wastewater

The raw wastewater (Table 2) shall be "typical" domestic, relative to key parameters such as BOD5, TSS, TKN and phosphorus. Wastewater of weaker strength due to infiltration/inflow or wastewater of excessive strength due to industrial waste, restaurant wastewater, etc., is not acceptable. It shall be documented that the raw wastewater is domestic.

When treatment capability is being tested, input/output data shall be obtained from each component of the system. These data shall include at a minimum:

- Raw wastewater characteristics based on a minimum of six (6) 24-hour composite samples collected at a minimum interval of one (1) week. The suggested guidelines for domestic wastewater are listed in Table 3.
- In addition to the parameters listed in Table 2, other incidental parameters should be identified. These would include fats, oil and grease, No_2 and No_3, TDS, and SO_4.

Table 2. Characteristics of typical domestic wastewater.

Parameter	Concentration Range
Biochemical oxygen demand (BOD5, 20^0C)	100-450 mg/L
Total Suspended Solids (TSS)	100-500 mg/L
TKN (as N)	25-70 mg/L
Total Phosphorus (as P)	3-20 mg/L
pH	6-9 units
Alkalinity (as CaCO3)	Greater than 60 mg/L (alkalinity addition may be required)
Temperature	Greater than 10^0 C and less than 30^0C

Table 3. Standard chemical parameters that should be included in a verification test to evaluate a treatment component.

PARAMETER	SAMPLE TYPE	SAMPLE LOCATION		TESTING LOCATION
		INFLUENT	EFFLUENT	
Alkalinity (as $CaCO_3$)	24 Hour composite	√	√	Laboratory
Ammonia (as N)	24 Hour composite	√	√	Laboratory
BOD_5	24 Hour composite	√	√	Laboratory
$CBOD_5$ Carbonaceous Biological Oxygen Demand (CBOD)	24 Hour composite		√	Laboratory
Dissolved Oxygen	Grab		√	Test Site
Orthophosphate (as P)	24 Hour composite		√	Laboratory
PH (standard units)	Grab	√	√	Test Site
Phosphorus, Total (as P)	24 Hour composite	√	√	Laboratory
Total Suspended Solids (TSS)	24 Hour composite	√	√	Laboratory

Temperature (°C)	Grab	√	√	Test Site
TKN (as N)	24 Hour composite	√	√	Laboratory
Total Nitrate/Nitrite (as N)	24 Hour composite	√	√	Laboratory
Total Coliform	Grab	√	√	Laboratory

Stress Testing

Wastewater shall be characterized in consideration of the influent flow pattern. The influent flow shall conform to the following pattern as representative of a typical residence(s) scenario:

- 6 a.m. – 9 a.m. approximately 35% of total daily flow
- 11 a.m. – 2 p.m. approximately 25% of total daily flow
- 5 p.m. – 8 p.m. approximately 40% of total daily flow

Total daily flow shall be within 100% ± 10% of the rated capacity of the technology undergoing testing based on a thirty (30) day average. When necessary to account for dilution by precipitation, such as during the evaluation of a free access sand filter, it may be helpful to add chlorides to the sampling matrix. The Testing Organization shall monitor and record influent flows daily to ensure that the dosing pattern is delivered as specified in the protocol. The Test Plan will specify the way in which flow rates will be measured (i.e.: totalizer flow meter, rate meter, etc…). One stress test shall be performed following every two months of normal operation during the technology evaluation, so that each of the five stress scenarios is addressed within the twelve (12) month evaluation period.

Stress testing shall involve the following simulations:

- Wash-day stress
- Working parent stress
- Low-loading stress
- Power/equipment failure stress
- Vacation stress

Wash-day stress simulation shall consist of three (3) wash-days in a five (5) day period with each wash-day separated by a 24-hour period. During a wash-day, the technology shall receive the normal flow pattern (Section 3.1.3.1); however, during the course of the first two (2) dosing periods per day, the hydraulic loading shall include three (3) wash loads [three (3) wash cycles and six (6) rinse cycles]. Common (readily available to consumers) detergent and non-chlorine bleach shall be added to each wash load at the manufacturer's recommended loading.

Working parent stress simulation shall consist of five (5) consecutive days when the technology is subjected to a flow pattern where approximately 40% of the total daily flow is received between 6 a.m. and 9 a.m. and approximately 60% of the total daily flow is received between 5 p.m. and 8 p.m., which shall include one (1) wash load [one (1) wash cycle and two (2) rinse cycles].

Low-loading stress simulation shall consist of testing the technology for 50% of the design flow loading for a period of 21 days. Approximately 35% of the total daily flow is received between 6 a.m. and 11 a.m., approximately 25% of the flow is received between 11 a.m. and 4 p.m. , and approximately 40 % of the flow is received between 5 p.m. and 10 p.m.

Power/equipment failure stress simulation shall consist of a flow pattern where approximately 40% of the total daily flow is received between 5 p.m. and 8 p.m. on the day when the power/equipment failure stress is initiated. Power to the technology shall then be turned off at 9 p.m. and the flow pattern shall be discontinued for 48 hours. After the 48-hour period, power shall be restored and the technology shall receive approximately 60% of the total daily flow over a three (3) hour period which shall include one (1) wash load [one (1) wash cycle and two (2) rinse cycles].

Vacation stress simulation shall consist of a flow pattern where approximately 35% of the total daily flow is received between 6 a.m. and 9 a.m. and approximately 25% of the total daily flow is received between 11 a.m. and 2 p.m. on the day that the vacation stress is initiated. The flow pattern shall be discontinued for eight (8) consecutive days with power continuing to be supplied to the technology. Between 5 p.m. and 8 p.m. of the ninth day, the technology shall receive 60% of the total daily flow, which shall include three (3) wash loads [three (3) wash cycles and six (6) rinse cycles].

Sampling Requirements for Pre-treatment or Final treatment Components

Location

Samples shall be collected of the raw influent and treated effluent. It may also be necessary or appropriate to collect samples at intermediate points if the equipment/process involves multiple stages. Effluent samples shall be collected from a location where wastewater is flowing (i.e. from a pipe or equivalent).

For technologies with subsurface discharge, a location shall be provided for collecting an effluent sample prior to discharge to the soil system. Given the potential variability in soil characteristics, a wide range of results for advanced treatment will likely occur if soil systems are taken into account, and it is unlikely that evaluation of the technology will be reproducible. If a particular technology involves the use of a soil system capable of being reproduced from one location to another, then the effluent sample may be collected at a location following the soil system. For such systems, the Test Plan shall provide documentation evidencing the reproducibility of the soil system. All natural systems involving features such as vegetation, wetlands, free access or buried sand filters, and soil systems shall have a single discharge point from which a discreet sample may be taken.

Frequency

Samples shall be collected at a minimum interval of once per month at all sampling locations. The Test Plan shall indicate the sampling frequency to be performed during verification testing. Samples shall be collected on the day each stress simulation is initiated and when approximately 50% of each stress test has been completed. Twenty-four (24) hours after the completion of wash-day, working-parent, low-loading, and vacation stress scenarios, samples shall be collected for six (6) consecutive days. Forty-eight (48) hours after the completion of the power/equipment failure stress, samples shall be collected for five (5) consecutive days. Samples shall also be collected for five (5) consecutive days at the end of the evaluation period. For grab samples, the protocol could select “random times” for collection to get statistically good data and possibly reduce the amount of “non-randomness” of the data.

Type

Sample type (24 hour composite, grab) shall be as indicated in Table I for the various parameters. All composite samples shall be collected proportional to flow or volume.

Sample Collection Procedures

The Test Plan shall indicate how the following sample collection procedures shall be performed during performance testing:

- Describe sampling and measurement equipment preparation (cleaning, decontamination, calibration, etc. as linked to QA/QC plan)
- Locate sample collection points
- Set up and place sampling equipment in service to obtain flow proportioned composite samples
- Collect grab samples for those parameters requiring a grab sample analysis
- Add appropriate preservatives to the sample containers and transport all sample containers in a chilled cooler ($4^{o}C$)
- Document the sample collection points and the sampling event recording all relevant information in the Field Log

Sample Labeling and Designation

The Test Plan shall establish the means by which samples will be labeled and uniquely identified.

Sample Packing/Shipping Procedures

All samples collected for laboratory analysis shall be shipped to the laboratory on the day of collection, following proper identification, chain-of-custody, preservation, and packaging procedures as established in the Test Plan.

Sample Chain of Custody

Test Plans for the evaluation of technologies shall specify the means by which sample chain of custody will be recorded.

Field Records and Documentation

A Field Log shall be prepared and maintained by the Testing Organization or a qualified designee throughout the course of the evaluation. The Field Log will be turned in to the Verification Organization for copying/filing/tracking when complete.

Field Log entries shall be recorded on a permanent medium. If errors are made in any Field Log, chain-of-custody record, or any other field record document, corrections may be made by crossing a single line through the error, entering the correct information, initialing, and dating the correction.

All entries in the Field Log shall be legible and contain accurate and inclusive documentation of all project activities. Once completed, the Field Log becomes an accountable document and shall be maintained as part of the project files.

The Test Plan shall include the qualifications of all persons involved in Field Log entries, chain-of-custody records or any other field record documentation.

All aspects of sample collection and handling, as well as visual observations, shall be documented in the Field Log. All sample collection equipment (where appropriate), field analytical equipment, and equipment used to make physical measurements shall be identified in the Field Log. All calculations, results, and calibration data for field sampling, field analytical, and field physical measurement equipment shall also be recorded in the Field Log, except where these are referenced as being recorded on approved field forms. All field analyses and measurements shall be traceable to the specific piece of field equipment utilized and to the field investigator collecting the sample, making the measurement, or conducting analyses. The Field Log shall be updated as fieldwork progresses.

These following minimum information shall be recorded in the Field Log:

- Date
- Weather Conditions
- Description of the work performed
- List of personnel involved, their position, and respective affiliations
- List of equipment on-site
- Description of decontamination performed
- List of sample I.D. numbers of environmental samples taken, and analyses requested
- The uniquely numbered COCs forwarded, and the recipient
- Identification of problems encountered and/or deviations from the test plan
- Calibrations performed
- Problems encountered and corrective actions taken

Analytical Procedures

The methods for the analysis of the parameters in Table I and any additional parameters to be evaluated during verification testing shall be those contained in 40 CFR Part 136, or alternate test procedures approved pursuant to 40 CFR Part 136. The laboratory shall be qualified by the Verification Organization prior to commencement of the evaluation. The Test Plan shall contain information about the procedures that the approved laboratory will follow during the evaluation process (i.e., SOPs, etc.). It is recommended that the laboratory be certified to perform the required analyses for test sites in states that have a certification program. For test sites in states without a certification program, it is recommended that the laboratory have NELAC certification, or a suitable substitute.

For testing to be performed at immediately at the test location (i.e., dissolved oxygen, pH, and temperature), the Test Plan shall describe the means by which the test site personnel have been trained and demonstrated proficiency in the use of the test equipment.

Additional Requirements applicable to conveyance accessory system studies

Evaluating Durability

The study should evaluate the long term ability of the product to withstand pressures, corrosive reactions, or mechanical vibration or mechanical use.

Evaluating Capacity

The study should evaluate the long term ability of the product to transmit fluid, without clogging, or breaking down etc.

Additional Requirements applicable to Final Treatment component field studies

Monitoring the zone of treatment and zone of disposal

Monitoring Tools

Monitoring the zone of disposal will be accomplished by employing devices such as lysimeters, monitoring wells, piezometers, and tensiometers, depending on the particular physical of chemical properties that the vendor is attempting to examine.

Parameter Measurements

Monitoring points shall be located such that for all parameters, input and output values can be obtained for all parameters of concern.

If the purpose of the study is to assess treatment relative to a function of depth or ordered sequence, more one or more input/output pairs of monitoring points may be needed.

Use of Existing Data

In general, existing data should not be relied on as the sole basis for verification The uncertainty and lack of control over the collection of existing data makes it difficult to develop binding assessments when existing data are used. However, the CORE recognizes that existing data can sometimes be valid, and can be useful to accomplish the assessment process, especially when the level of uncertainty is low compared to the level of concern. Therefore, existing data can be used at the discretion and of the CORE or the Verification Organization. Existing data may be included as a separate section in the Verification Report, but such inclusion shall be clearly indicated as non-quality assured data. When CORE uses existing data to develop an assessment, an adequate report shall be provided for the record that describes how the assessment was developed.

Site, Operations, and Maintenance Considerations

General

Installation and operation and maintenance requirements for the technology shall be overseen by the Testing Organization and shall be performed in accordance with the Vendor's written instructions. The Test Plan shall address how the installation requirements and maintenance performed will be documented during the course of verification testing. The Vendor shall not be permitted to perform operation or maintenance tasks without direct supervision by the Testing Organization.

Mechanical Components

Wastewater treatment processes may involve the use of compressors or blowers, mixers, and chemical and wastewater pumps. Performance and reliability of the equipment during the test period shall be observed and documented, including equipment failure rates, replacement rates, and the existence and use of duplicate or standby equipment. If necessary, the testing period may be extended to a second year of operation to fully evaluate equipment performance, reliability, and durability. This would result in a second verification of the technology, with an increased focus on operation and maintenance issues.

Electrical/Instrumentation Components

The plan shall propose how electrical components, particularly those that might be adversely affected by the corrosive atmosphere of a wastewater treatment process can be monitored for performance and durability during the course of verification testing and instrumentation. This discussion shall also include alarm systems that will be used during the course of verification testing. The Test Plan shall indicate the means by which these components will be evaluated for durability and corrosion resistance.

Chemical Feed Components

The Test Plan shall include testing requirements for the verification of the chemical feed delivery rate. Chemical feed systems may involve alkalinity addition to maintain the proper pH level, chemical addition for phosphorus reduction and/or carbon source for denitrification. The Test Plan shall also specify observation of the chemical feed components following completion of the evaluation period. All observations (i.e. corrosion, wear, etc.) shall be noted in the Field Log.

Other Components

The Vendor may have additional components relative to the operation and maintenance of the technology to be considered during the test period. The Test Plan shall indicate the means and frequency by which these components are to be evaluated.

Byproducts or Residuals

A advanced treatment process may involve generation of byproducts or residuals, which shall require off-site disposal. Such byproducts or residuals, when generated, may include septage, sludge, ion exchange regenerates/brines, etc.. The quantity and quality of any byproducts or residuals generated during the evaluation process shall be recorded. The volume, mass and other characteristics of the byproducts or residuals (such as TSS, VSS, etc.) shall be recorded.

Level of Operator Skill and Attention Required

All wastewater treatment plants require periodic operator attention. The Test Plan shall address how the required operation/maintenance tasks, along with an indication of the extent (i.e., hours per month) and level of operator attention required to maintain performance, will be determined and recorded during the verification process.

Electrical Usage

The Testing Organization shall record the monthly energy consumption (kilowatt hours) of the technology. This may require a dedicated electric meter. The intent is to provide information on the power source (single or three phase), voltage, and the overall electric usage of the technology. If the Vendor claims an energy recovery benefit, the Test Plan shall address the means by which this claim will be verified.

Chemical Usage

Any chemicals added to the technology during verification testing shall be recorded and quantified. The Test Plan shall identify chemicals used with the technology and verification of the chemical shall be noted in the Field Log.

Environmental Considerations

Noise

Noise levels associated with mechanical equipment (particularly compressors and blowers) shall be verified during the evaluation period. A decibel meter shall be used to measure the noise level associated with the technology. Measurements shall be taken one meter from the source(s) at one and a half meters above the ground, at 90° intervals in four (4) directions. Any mitigation measures for noise control provided by the Vendor shall be noted. Noise levels shall be measured once during the evaluation, approximately one month after completion of start-up period.

Odors

Monthly observations shall be made by the Testing Organization during the evaluation period with respect to odors generated by the technology. The observation shall be qualitative and shall include odor strength (intensity) and type (attribute). If the treatment system is buried, covered or otherwise has odor containment, the means of ventilating the compartment(s), including any odor treatment systems shall be noted.

Waste Management Plan

The Test Plan shall describe the procedures to be followed to assure that wastes generated during the verification testing are managed in a manner that is protective of human health and the environment. The management of wastes includes the containerization, characterization, transportation, and disposal of wastes.

The Health and safety plan

The safety procedures shall address safety considerations, which relate to the health and safety of personnel required to work on the site of the test equipment and persons visiting the site. Many of these items will be covered by site inspections and construction and operating permits issued by responsible agencies. They will include:

- Regulations covering the storage and transport of chemicals.
- Site specific spill response plan with respect to wastewater and any chemical usage.
- Site specific health and safety plan addressing storage and handling of any chemicals.
- Regulations regarding disposal of byproducts.
- Conformance with the National Electric Code.
- Provision of parking facilities, sanitary facilities and drinking water.
- Provision of and access to fire extinguishers.
- Regulations covering site security.
- Conformance to any building permits requirement such as provision of handicap access or other health and safety requirements.

Ventilation of equipment or of trailers or buildings housing equipment, if gases generated by the equipment could present a safety hazard.

Warranty and Maintenance Requirements

The vendor shall clearly describe the terms of any warranties. In addition, the vendor shall provide a proposal to offer warranty and maintenance benefits to protect the owners of the products.

Submitting the Test Plan to the Review Entity

Once a test plan is properly developed, it can be submitted to any one of the members of the Consortium of Review Entities. The plan shall be presented along with enough copies to be distributed to all the consortium members. An application form (Table 11) and the applicable fees shall accompany the package.

Implementing the Verification Testing Program

Minimum Requirements

Each verification project field study shall obtain the following data and records, and shall provide it in total to the review entity in the final report. The data shall include *descriptive* data and *experimental* data.

Descriptive data are data related to physical descriptions of the site, the nature of the soils or geology, and the nature of the system or component being tested or verified. Experimental data are observed facts obtained while conducting the experiments.

Each facility that intends to perform the testing proposed in the approved Test Plan shall comply with the requirements of this part.

Affidavit of Intent

Each facility that intends to perform the testing proposed in the approved Test Plan shall sign and have notarized an Affidavit of Intent to perform the proposed study in accordance with the proposal and any conditions of approval. A sample of Affidavit of Intent is provided in Appendix 7.

Verification Test Site Characteristics

Minimum requirements for a test site include:

- The test site shall have a suitable means and location for sampling of raw wastewater and a sampling arrangement to collect representative samples.
- The test site shall be capable of controlled dosing to the technology being evaluated to simulate a diurnal flow variation and to allow for stress testing. The test site shall have a sufficient flow of wastewater to accomplish the required controlled dosing pattern.
- The test site shall be accessible, relative to operational control and oversight, and secure to prevent tampering by outside parties.
- The test site shall have a legal means of wastewater disposal of both the effluent from the testing operation and for any untreated wastewater generated when testing is not occurring.
- The test site shall be capable of accommodating the start up period, testing period, stress testing and any additional testing activities, such as a determination of operations and maintenance requirements.

Duration of Testing

The duration of the evaluation period shall be a minimum of one (1) year following a maximum start-up period of eight (8) weeks. When the technology performance has stabilized during the start-up period, the Vendor shall advise the Testing Organization that the evaluation period can commence. This evaluation period duration will allow for an assessment of the impact of seasonal variations on performance.

Maintaining Records

All records shall be maintained at the site and shall be available for review by the Consortium of Review Entities or the designated agent.

Data Management

Data Reduction, Evaluation, and Reporting

The analytical data generated by the laboratory shall be reviewed internally prior to submission to Testing Organization and/or the Verification Organization to assure the usability/validity of the reported results. This internal data review process will consist of data generation, reduction, a minimum of three levels of documented review, and reporting. The data generated by on-site tests (dissolved oxygen, pH, temperature), will not be validated by an independent reviewer. Independent data validation will be performed on definitive data collected, i.e., the laboratory.

The data reduction, review, reporting, and validation procedures described in this section will ensure that (1) complete documentation is maintained, (2) transcription and data reduction errors are minimized, (3) the data are reviewed and documented, and (4) the reported results are qualified. Laboratory data reduction and verification procedures are required to ensure that the overall objectives of analysis and reporting meet method and project specifications.

Data Reduction

Analytical data are first generated in raw form at the instrument. These data may be in either graphic form or printed in tabular form. Specific data reduction procedures, generation procedures, and calculations, which convert raw results into a form from which conclusions can be drawn regarding equipment performance, shall be detailed in the laboratory SOPs for each analytical method used. Analytical results shall be reported consistently. Data reduction shall be performed by a laboratory QA/QC Chemist, or qualified designee, who is experienced with the particular analysis and knowledgeable of project QA/QC requirements.

Data Review

The technician/analyst who generates the analytical data is responsible for the correctness and completeness of those data. This review process involves evaluation of both the results of the QC data and the professional judgement of the person(s) conducting the review. This application of technical knowledge and experience to the evaluation of data is essential in ensuring that high quality data are generated.

The Test Plan shall document the data review procedures which will be followed by laboratory personnel. For example, the data review may be conducted at the laboratory level prior to submittal following this three step process:

Level 1 Technical Data Review

In the Level 1 data review process, the analysts review the quality of their work based on an established set of guidelines. The review will ensure at a minimum that appropriate preparation, analysis, and SOPs have been followed; analytical results are correct and complete; QC samples are within established control limits; and that documentation is complete (e.g., any anomalies have been documented).

Level 2 Technical Data Review

This level of review will be performed by a supervisor or data review specialist whose function is to provide an independent review of the data package. This review will also be conducted according to an established set of guidelines (i.e., method requirements and laboratory SOPs). The Level 2 review includes a review of qualitative and quantitative data and review of documented anomalies.

Level 3 Administrative Data Review

The final review of the data, prior to submittal, will be performed by the QA/QC Officer or program administrator at the laboratory. This level of review provides a total overview of the data package to ensure its consistency and compliance with project requirements.

Data Validation

The Testing Organization shall verify that the data forms, data acquisition and reduction are complete and accurate. A field supervisor or another technical member of the Testing Organization shall review calculations and inspect logbooks and data sheets. Laboratory operators shall examine calibration and QC records, verify all instrument systems are in proper working order and ensure that QA objectives have been met.

Analytical outlier data are defined as those QC data lying outside a specific QC objective window for precision and accuracy for a given analytical method. Should QC data be outside control limits, the laboratory supervisor shall notify the Testing Organization and investigate the cause of the problem. If the cause is an analytical problem, the sample shall be reanalyzed. If the cause can be attributed to the sample matrix, the result shall be flagged with a data qualifier. This data qualifier shall be included and explained in the final analytical report from the laboratory.

The following are examples of validation flags that may be applied to the data:

U	The analyte was analyzed for but was not detected. The associated numerical value is at or below the method detection limit.
F	The analyte was positively identified, but the numerical value is below the PQL.
M	A matrix effect was present.
B	The analyte was found in the associated blank, as well as in the sample.
R	The data is unusable due to deficiencies in the ability to analyze the sample and meet QC criteria.

Data Reporting

The laboratory(s) analytical reports shall conform to the following minimum reporting requirements:

A table, which matches the contract laboratory sample ID to the QA laboratory split sample ID collected. This table also will identify all duplicates and blanks with their corresponding samples.

A "Cooler Receipt Form" for the purposes of noting problems in sample packaging, chain-of-custody, and sample preservation.

A copy of the chain-of-custody submitted with the samples.

Analytical summaries which report results for all samples, blanks, and QC for each analytical fraction. The detection limits are those established by the methods identified and all analytes will be reported. The referenced analytical methods (including preparation methods), date of sample collection, data of extraction, and the date of analysis, as well as any dilution factor, also are required.

Matrix Duplicates - Relative percent difference (RPD) values will be reported, as well as the project/analyte control limits.

Matrix Spike/Matrix Spike Duplicates - The relative percent difference will be reported for each spiked compound. Concentrations for each spiked compound and the method-specific control limits will be reported.

Project Data Flow and Transfer

Data flow from the laboratory and test site to the Verification Organization shall follow established procedures to ensure that data are properly tracked, reviewed, and validated for use. All test site data and laboratory data packages shall be submitted to the Verification Organization Project Manager. No changes to the laboratory data packages shall be made without approval from the Verification Organization. The Test Plan shall describe the format, schedule and means (i.e., electronic format, tables, etc.) for reporting data to the Verification Organization.

Interim Reports

Reports shall be submitted by the Testing Organization to the Verification Organization during the course of the evaluation to ensure that any problems arising during sampling and analysis are investigated and corrected as quickly as possible. The following sections describe the types of QC reports that shall be submitted.

Sampling Report

The Testing Organization Project Manager or designee shall prepare a report of each sampling event during the evaluation period following all sampling activities. This report shall consist of a brief summary of the major actions performed, any problems encountered since the previous report, and corrective actions taken to correct problems. This information shall be kept in project files along with the COC forms and the Field Log documenting the sampling activities.

Data Summary Report

The laboratory shall provide tabulated summaries of the data to the Testing Organization in both electronic and hard copy format. The summaries will show the sample identifiers, the analyses performed, and the measured concentration or effects, including all relevant qualifiers and validation flags. A brief narrative statement on the overall data quality and quantity will also accompany the tabulated summaries. The Testing Organization Project Manager will coordinate with the laboratory project manager to define the format of these data summary reports. All data summary reports shall also be forwarded to the Verification Organization Project Manager following review by the Testing Organization Project Manager.

Operation and Maintenance Report

The Testing Organization Project Manager or designee shall prepare a report of the operation and maintenance activities that were performed during the verification testing period. This report shall include a summary of the recommended operation and maintenance activities for the technology and any additional operation or maintenance tasks that were required during the test period. This report shall clearly delineate when the Vendor provided technical assistance to the Testing Organization.

Quality Control and Analytical Report

This report shall be used to address the quality control practices employed during the project. It shall also summarize the problems identified in the sampling reports, which are likely to impact

the quality of the data. The following required elements represent the minimum items to be included in the report:

A project description, including report organization and background information
Summaries of the sampling procedures, sample packaging, sample transportation, and decontamination procedures.
A summary of the laboratory analytical methods, detection limits, quality control activities, deviations from planned activities, and a summary of the data quality for each analysis and matrix.
An assessment of the sampling and analyses techniques, an evaluation of the data quality of each parameter, and an evaluation of the usability of the data.
A summary of the field or analytical procedures that could be changed or modified to better characterize the raw influent and treated effluent in future evaluations.
An overall discussion of the quality of the environmental data collected during the evaluation and whether or not it meets the project objectives.
Identification of the QA samples which were split and sent to the laboratory and to the QA laboratory.
All cooler receipt and COC forms associated with the required sample results.
A laboratory case narrative to be included in the results if nonconformances or other evaluation events affect the sample results.
The portion of the primary field sample results and associated batch QC results, which conform to the QA samples submitted to the QA laboratory.

Developing a Final Report

The final report can be developed by the vendor, or when specified by the CORE, a representative of the Verification Center.

Each final report shall contain the following information, presented in a document format:

I. Abstract

II. Introduction
    Description of the product
    Need for the research
    Hypotheses to be tested
    Anticipated outcome

III. Materials and Methods
    Site Description
    Environmental Conditions (Weather, Temperature etc.)
    Analytical Techniques

IV. Results
    Description of the Experimental Design and Study
    Results of the Verification Project
    Present and discuss the data in detail
    Compare the data to the methods and hypotheses

V. Discussion
    Provide a narrative discussion of the implications of the results. Results and discussion can be combined if convenient to enable a more succinct report.

VI. Summary and Conclusions

Did it accomplish the goals?
Explain how hypotheses were proven or not
Discuss how the regulatory hurdles can he overcome based on the results of the study

Guidance for Review Entities

This section establishes the guidance for the review entities or proxy reviewers to follow. Three phases of review that CORE or individual review entities will do are:

1. Accept an application from the Vendor that includes a proposal constructed in accordance with the guidance in Part 1.
2. Review the Verification Program report and assess the results of the Verification Program
3. Approve Innovative and alternative Technology for alternate uses based on comparison of certified results against the list of requirements maintained by each domain specific review entity.

Standard Approach for Accepting and Reviewing Applications to Conduct a Verification Program

The standard procedure for accepting and reviewing applications is specified in this section.

The process for processing the application for ITV Innovative and alternative Technology approvals is graphically displayed in Figure 2. Each application should include all the information required in the "Guidance for Vendors." The review entities or CORE shall pay particular attention to the hypothesis or hypotheses stated for the technology. Each hypothesis should be structured in a way that can result in a scientifically valid conclusion regarding the ability of the technology to achieve one of the standard parameters in Table 4. If it does not, a new standard parameter may need to be created, but this should be done in consultation with CORE. Vague hypotheses or hypotheses that attempt to prove things that are not listed as standard parameters shall not be accepted. Remember that this protocol relies on acceptance of the premise that most if not all the regulatory requirements can be shown to relate to a small number of standard parameters.

Standard Approach for Assessing Verification Program Reports

The *assessment* phase of the review process relies on the expectation that the verification project was conducted properly, and that the report was fully and adequately developed. It should be possible for a Review Entity to read the report, and to compile a table of approved parameter values.

For example, if a report concludes that a Pre-Treatment; Advanced Treatment Vessel can reduce Total Nitrogen to 10 mg/L at least 90% of the time, that value will be entered into a product performance table as shown below in Table 6 Standard parameters that are relevant when attempting to obtain Alternative Requirement Approvals by Technology Verification Testing in New Jersey.

Objective	Relevant Parameters	Existing Standards	Domain
Reduced Leach Field Size	LTAR	N.J.A.C. 7:9A-10.2(b) and (c)	New Jersey

	LTARX VAR	LTAR= 5K - 1.2/log K where (K=ft/min and LTAR =gallons/ft2/day	
Reduced Lot Size in Pinelands	N03	2 mg/L at property boundary Using a nitrate mass balance model	New Jersey
Reduced Lot Size in other nitrogen limiting area "50 or more Realty Improvements"	N03	N.J.A.C. 7:9-6: 5.2 mg/L at property boundary Using a nitrate mass balance model	New Jersey

Table 7.

When there is some question about the validity of the conclusions of a report, it will be necessary for the Consortium of review entities to jointly review and assess the findings. As this process matures, a sub-committee of review entities or a third party proxy review may be used for this phase of the approval process.

Standard Approach for Approving Innovative and Alternative Technology

After an *assessment* is complete, each review entity will approach the approval phase in the same manner but will review the results against a specific individualized set of alternative requirements for the particular product. This individual set of requirements will be founded on its own set of rules, customs and regulatory or social needs. This separation of assessment and approval is the foundation of the Tier 2 protocol, since it enables a standardized and universal approval protocol, while not assuming to impose approvals on one entity that is simply not possible for another.

Specifically, at this point in the Tier 2 protocol, the vendor will have developed a proposal, they will have conducted the verification program, and they will have produced a final report. The review entity will have completed the assessment of the final report. This guidance provides a model for completing the final phase of the protocol, which may be called the Tier 3 level. Tier 3 is when the review entity will approve a technology based on the standardized predecessor steps.

In order to conduct approvals consistently from one domain to another, it is necessary for each domain to establish a table of an Alternate Requirements Table as shown in Table 9. If a table exists, a review entity can compare the Approved Value from the Product Performance Table (See Table 6 Standard parameters that are relevant when attempting to obtain Alternative Requirement Approvals by Technology Verification Testing in New Jersey.

Objective	Relevant Parameters	Existing Standards	Domain
Reduced Leach Field Size	LTAR LTARX VAR	N.J.A.C. 7:9A-10.2(b) and (c) LTAR= 5K - 1.2/log K where (K=ft/min and LTAR =gallons/ft2/day	New Jersey
Reduced Lot Size in Pinelands	N03	2 mg/L at property boundary Using a nitrate mass balance model	New Jersey
Reduced Lot Size in other nitrogen limiting area “50 or more Realty Improvements”	N03	N.J.A.C. 7:9-6: 5.2 mg/L at property boundary Using a nitrate mass balance model	New Jersey

Table 7) to the Alternate Requirements

When possible, the review entity should provide a list of the relevant standards that will need to be evaluated to obtain Alternate Approvals for selected objectives. This should be provided in tabular format, such as provided (for New Jersey) in Table 6.

Appendices

Appendix 1: Definitions

“Class of environmental technology“ means the type of pollution prevention, pollution control, site assessment and remediation, data management system or control, or environmental management practices. A class of environmental technology could include the following:
a. Environmental Monitoring Technology“ means any method, procedure or process for evaluating or determining environmental data conditions or results.
b. Recycling“ means any method, process, system or facility for the recovery and reuse of Material that would otherwise become a waste and is returned as a raw material or product.
c. Pollution Prevention Technology means one method or process for the reduction of the use of hazardous substance or other substances of concern in the production and manufacturing process or the prevention of an emission, discharge and/or residue from being generated by a system or facility.
d. Environmental Control Technology“ means any method, process or system to reduce or control emissions/or discharges from a facility.
e. “Remediation Technology“ means any method, process, system or facility to recover and contra contamination in soil and/or groundwater at a site.

“Consortium of Review Entities“ means a group of Review entities that have agreed to accept the Tier 2 protocol. This is also known as CORE.

“Domain“ means the geographic area or governmental unit (state, county, municipality etc.) for which a technology is intended to be used.

“Environmental technology“ means a new, innovative or alternative method, procedure, process, system or facility, which is not a proven technology. An environmental technology could include a proven technology in one field of use that is applied to a new or different environmental problem. The environmental technology must have a substantial likelihood of achieving greater continuous environmental protection than other technologies in current practices or at least comparable results at lower cost in terms of energy, economics or environmental impacts.

“Guidance” means the document(s) produced by a review entity or a Consortium of Review Entities that identifies the procedures constituting the Tier 2 protocol.

“Net Beneficial Effect” means that the sum total of the overall environmental impacts of the environmental technology is less than the existing or baseline conditions in which the environmental technology is being introduced or used. The overall environmental technology in terms of inputs of raw materials, water, and energy usage and the outputs of air emissions, wastewater discharges, solid waste residue including any recycling and product, must result in a significant reduction of the impacts to the environment when compared to the baseline conditions for the same or equivalent inputs and outputs. The net beneficial effect should not result in an exceedance of any existing state-of-the-art emissions or discharges. The “net beneficial effect“ should enhance environmental performance producing a more efficient less polluting outcome beyond compliance regulation.

“Onsite wastewater disposal systems” means the set of components or systems that treat, convey, and dispose of domestic wastewater onsite. This includes septic systems, aerobic treatment systems, activated sludge systems, recirculating sand filters, gravel, pipes, and leach chambers

“Performance data” means any parameter or piece of information collected or produced from measurements, analyses or models of environmental processes, conditions and effects of constituents of concerns on human health and the environment including results from laboratory analyses, verification or pilots and the work performed to obtain use or report information pertaining to process method procedure, equipment, system or facility.

“Proven Technology” means a method, procedure, process, system or facility for pollution prevention, pollution control, site assessment and remediation, data management systems or control or environmental management practices which has been permitted and has a substantial operational record.

“Proxy reviewer” means a designated group or individual that is technically proficient to evaluate the particular type of data. A center can function as a proxy reviewer.

“Quality Assurance” (QA) means an integrated system of management activities involving planning, implementation, assessment, reporting, and quality improvement to ensure that a process, item, or service is of the type and quality needed and expected by the client.

“Quality Control” (QC) means the overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established by the customer-, operational techniques and activities that are used to fulfill requirements for quality.
“Reciprocity” means that the environmental technology data and technology performance is acceptable between states without further demonstrations. Further, when required it means that a Tier 2 protocol has been established for use as a regulatory or permit template between states.

“Review Entity” means the agency of government (or proxy reviewer) authorized to review and approve alternate technology for a specified domain. In some cases, a proxy will be designated to represent the review entity.

“Stage of environmental technology Development“ means the common cycle of environmental technology development including the following.
a. “Treatability, pilot or bench scale study“ means a procedure to test the environmental technology under laboratory conditions.
b. “Full-scale field demonstration“ means a process to test the environmental technology to obtain performance data under field operating conditions.
c. “Start-up/compliance testing“ means the ongoing testing of the environmental technology’s ability to meet performance standards at the site where it will be deployed.

“Test Plan” means the plan proposed by a vendor for conducting the verification project study intended to verify whether or not a technology can achieve certain performance claims. It is also referred to a the IATV proposal or plan.

“Testing organization“ means the test center or approved individuals or organizations that agree to conduct the study in accordance with the approved test plan.

“Validate “ means to confirm by evaluation and assessment that a particular requirement for a specific intended use is met.

“Vendor“ means the person applying for an innovative or alternative approval.

“Verification Program Plan” means the same as a test plan.

“Verification project” means the scientific program, designed by the Vendor and implemented by the Testing organization, that is intended to verify the product performance claims made by the Vendor.

“Verified performance criteria”

“Verify“ means to confirm by evaluation and assessment that the validated data or performance meets specific requirements under specific conditions through the host State verification process.

“Zone of disposal,” means the Final Treatment components that enable the wastewater that has filtered through the zone of treatment to leach into the underlying ground. This zone must be permeable to accept the volume of water that leaches into it so that an anaerobic zone does not form above it in the zone of treatment.

“Zone of treatment,” means the Final Treatment components in which active biological processes are encouraged to reduce levels of bacteria, to convert ammonia to nitrate, and which is typically an aerobic zone.

Appendix 2: Acronyms

BOD	biochemical oxygen demand
CBOD	carbonaceous biochemical oxygen demand
COC	chain-of-custody
CORE	Consortium of Review Entities
EPA	United States Environmental Protection Agency
ETV	Environmental Technology Verification Program
IATV	Innovative and Alternative Technology Verification
mg/L	milligrams per liter
NIST	National Institute of Standards and Technology
NSF	NSF International
PQL	practical quantitation limit
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
RPD	relative percent difference
SOP	standard operating procedure

TKN	total Kjeldahl nitrogen

Appendix 3: The Database Management System Design Specifications

A database management system (DBMS) will enable the States to follow a uniform reciprocal approval process for innovative and alternative onsite wastewater disposal systems or components. The DBMS relies on three fundamental sets of facts, and some functional comparisons. The general schema for the DBMS is shown in Figure 1.

When the DBMS is complete, it will enable review entities (States, health departments, etc.) and vendors/applicants to follow a standard procedure (protocol) to Specify domain specific alternative requirements for use of the approved technology. It will also allow both vendors and review entities to:

1. View Test Performance Claims
2. View Review Performance Testing Reports and Approve or Deny
3. View characteristics of products that have obtained assessments from other members of the consortium of review entities.

The following summary explains in short how I envision the system working.

The logic behind this system is that there are four classes of components, as seen in Table 3. These are:

1. Pretreatment Components
2. Conveyance Components
3. Final Treatment Components
4. Accessories

First, the DBMS system is comprised of four tables.

1. A Parameter Table (Table 4)
2. A Component Class Table (Table 5)

A Performance Table (Table 6 Standard parameters that are relevant when attempting to obtain Alternative Requirement Approvals by Technology Verification Testing in New Jersey.

Objective	Relevant Parameters	Existing Standards	Domain
Reduced Leach Field Size	LTAR LTARX VAR	N.J.A.C. 7:9A-10.2(b) and (c) LTAR= 5K - 1.2/log K where (K=ft/min and LTAR =gallons/ft2/day	New Jersey
Reduced Lot Size in Pinelands	N03	2 mg/L at property boundary Using a nitrate mass balance model	New Jersey
Reduced Lot Size in other nitrogen limiting area “50 or more Realty Improvements”	N03	N.J.A.C. 7:9-6: 5.2 mg/L at property boundary Using a nitrate mass balance model	New Jersey

3. Table 7)
4. An Alternative Requirements Table (Table 9)

The Innovative and alternative Technology Proposal requires a vendor to make specific claims that will be tested during the verification test phase. For example, a typical claim might be as follows:

> "This product (xyz) can treat domestic wastewater to a level such that it discharges less than 10 mg/L of total nitrogen, at least 95% of the time."
>
> Or;
>
> "This component (Ajax pipe) will be as durable in terms of strength, resistance to corrosion as an ABS (ASTM D-271) pipe."

I also need to establish a standard for assessing soil absorption field area in order to assess products like Elgin and Infiltrator. I believe it will be based on LTAR and a concept such as used by Connecticut that they call "effective leaching area."

As you can see, in order to accomplish this first step, there is a need to establish a list of parameters that can cover all the possible claims that can be tested. My proposed list is provided in Table 1.

After the claim is tested and either substantiated or modified, the DBMS will be loaded with the parameters and performance achieved. This information will populate the Product Performance

Component Code		Component Class	Component Subclass
Class	Sub Class		
1	A	Pre-Treatment	Septic Tanks
1	B	Pre-Treatment	Filters
1	C	Pre-Treatment	Advanced Treatment/Other
2	A	Final Treatment	Zone of Treatment
2	B	Final Treatment	Zone of Disposal
2	C	Final Treatment	Synthetic Media
3	A	Conveyance	Pipes
3	B	Conveyance	Distribution box
3	C	Conveyance	Effluent Distribution Gravel
3	D	Conveyance	Effluent Distribution Gravel free
3	E	Conveyance	Effluent Distribution Drip Irrigation
3	F	Conveyance	Pump Vaults
3	G	Conveyance	Valves
3	H	Conveyance	Siphons
3	I	Conveyance	Pumps
4	A	Accessory	Controls
4	B	Accessory	Alarms
4	C	Accessory	Baffles
4	D	Accessory	Flow Divider

4	E	Accessory	Risers
4	F	Accessory	Fittings

Table 6 Standard parameters that are relevant when attempting to obtain Alternative Requirement Approvals by Technology Verification Testing in New Jersey.

Objective	Relevant Parameters	Existing Standards	Domain
Reduced Leach Field Size	LTAR LTARX VAR	N.J.A.C. 7:9A-10.2(b) and (c) LTAR= 5K - 1.2/log K where (K=ft/min and LTAR =gallons/ft2/day	New Jersey
Reduced Lot Size in Pinelands	N03	2 mg/L at property boundary Using a nitrate mass balance model	New Jersey
Reduced Lot Size in other nitrogen limiting area "50 or more Realty Improvements"	N03	N.J.A.C. 7:9-6: 5.2 mg/L at property boundary Using a nitrate mass balance model	New Jersey

Table 7. This table will be the same for all the participating States or subscribers to the protocol, and can be made available through a national web site.

Table 2 is a list of component classes and subclasses. If this sort of approach is possible, every thing required in a system can be classified. This enables the use of the

Finally, the DBMS can provide a set of alternative requirements (Table 4) that are specific to the technology, and that are specific to the particular approval entity. This is the table that will be populated by each review entity or State, and thus will allow sovereignty for the purposes of allowing alternatives to the regulations.

As you can see, this DBMS requires us to establish a list of parameters for Table 1 that will enable the review of most any technology. Below in Table 1 you will see what I think can work using the hypothesis statement approach I outlined above. In order to complete this project, I need your help to decide what other parameters you think we need.

Table 4. Parameter Table

Parameter Index	Parameter Name	Parameter Code	Standard-Units
1	Carbonaceous Biological Oxygen Demand	CBOD5	mg/L
2	Durability Strength Index	DUR_S	Dimensionless
3	Durability Corrosion index	DUR_C	Dimensionless
4	Durability Water Tightness index	DUR_WT	Dimensionless
5	Long Term Acceptance Rate	LTAR	Gallons/Ft2-day
6	Effective Leaching Area	ELA	Ft^2/Ft^2
7	Long Term Acceptance Rate Multiplier	LTARX	dimensionless
8	Mechanical Complexity Index	CMPLXTY	Dimensionless Classes 1. No moving parts 2. If Moving parts fail, the system works equivalent to a conventional septic system 3. If Moving parts fail, the system requires immediate maintenance
9	Nitrate Nitrogen	N03	mg/L
10	Total Coliform	TC	number/100 ml
11	Total Kjeldahl Nitrogen	TKN	Mg/L
12	Total Nitrogen	TN	mg/L
13	Total Nitrogen Removal Efficiency	TNRR	Percent
14	Total Phosphorus	TP	mg/L
15	Total Suspended Solids	TSS	mg/L
16	Fecal Coliform	FC	number/100 ml
17	Volumetric Acceptance Rate	VAR	Gallons/Ft2-day
18	Durability Robustness index	DUR_R	Dimensionless
19	Capacity	CV	Volume

Table 5. Component Class Table

Component Code		Component Class	Component Subclass
Class	Sub Class		
1	A	Pre-Treatment	Septic Tanks
1	B	Pre-Treatment	Filters
1	C	Pre-Treatment	Advanced Treatment/Other
2	A	Final Treatment	Zone of Treatment
2	B	Final Treatment	Zone of Disposal
2	C	Final Treatment	Synthetic Media
3	A	Conveyance	Pipes
3	B	Conveyance	Distribution box
3	C	Conveyance	Effluent Distribution Gravel
3	D	Conveyance	Effluent Distribution Gravel free
3	E	Conveyance	Effluent Distribution Drip Irrigation
3	F	Conveyance	Pump Vaults
3	G	Conveyance	Valves
3	H	Conveyance	Siphons
3	I	Conveyance	Pumps
4	A	Accessory	Controls
4	B	Accessory	Alarms
4	C	Accessory	Baffles
4	D	Accessory	Flow Divider
4	E	Accessory	Risers
4	F	Accessory	Fittings

Table 6 Standard parameters that are relevant when attempting to obtain Alternative Requirement Approvals by Technology Verification Testing in New Jersey.

Objective	Relevant Parameters	Existing Standards	Domain
Reduced Leach Field Size	LTAR LTARX VAR	N.J.A.C. 7:9A-10.2(b) and (c) LTAR= 5K - 1.2/log K where (K=ft/min and LTAR =gallons/ft2/day	New Jersey
Reduced Lot Size in Pinelands	N03	2 mg/L at property boundary Using a nitrate mass balance model	New Jersey
Reduced Lot Size in other nitrogen limiting area "50 or more Realty Improvements"	N03	N.J.A.C. 7:9-6: 5.2 mg/L at property boundary Using a nitrate mass balance model	New Jersey

Table 7. Product Performance Table

Technology	Component Class Code	Parameter	Parameter Code	units	Approved Value	Data Statistics					
						Mean	Median	N	std	Max	Min
XYZ Treatment Vessel	1C	Total Nitrogen	TN	mg/L	10						
Ajax pipe	3A	Durability Index	DUR_S	Yes/No	Yes						
No Gravel Inc.	3D	Effective Leaching Area	ELA	Ft^2/Ft^2	1						
Ajax pipe	3A	Durability Index	DUR_C	Yes/No	Yes						
Ajax pipe	3A	Durability Index	DUR_WT	Yes/No	Yes						
Conventional Septic system	1A										
BioMicrobics FAST System	1C	Nitrate Nitrogen	NO3	mg/L	14	15	11	71	13	63	3
Cromaglass System	1C	Nitrate Nitrogen	NO3	mg/L	14	8	5	98	14	121	1
Amphidrome System	1C	Nitrate Nitrogen	NO3	mg/L	14	12	10	69	10	62	1
Ashco RFSIII System	1C	Nitrate Nitrogen	NO3	mg/L	20			18			
AWT Bioclere Model 16/12 Wastewater Treatment System	1C	Nitrate Nitrogen	NO3	MG/L		14	10	103	16	103	3
AWT Bioclere Model 16/12 Wastewater Treatment System	1C	Carbonaceous Biological Oxygen Demand	CBOD5	MG/L		11	11	-	4	26	4
AWT Bioclere Model 16/12 Wastewater Treatment System	1C	Total Dissolved Solids	TSS	MG/L		5	5	-	2	15	<2

Table 8. Minimum Level of Uncertainty Associated with Measurements and Parameters

Uncertainty Code	Narrative
1	Median
2	Arithmetic Mean
3	75 percentile
4	100 percentile
5	95% Confidence Interval (parametric)
6	95% Confidence Interval (non-parametric)
7	No measurable uncertainty

Table 9. Alternate Requirements Table (One of these must be developed by each domain or review entity.

Component Class Code	Parameter Code	units	Numeric Approved Value	Non-Numeric Approved Value	Alternative Requirements
5	TN	mg/L	10	10	Use of this product entitles the owner/operator to use 10 mg/L as the nitrate loading term in the nitrate dilution model for determining housing lot density
9	ELA	Ft^2/Ft^2	1	1	Use of this product entitles the owner/operator to base the sizing of the absorption field (zone of treatment) equivalent to the regulatory standard
9	ELA	Ft^2/Ft^2	2	2	Use of this product entitles the owner/operator to base the sizing of the absorption field (zone of treatment) equivalent to 0.5 times the regulatory standard
6	DUR_S	Yes/No	0	Yes	Use of this product entitles the owner/operator to use this pipe in lieu of the PVC(ASTM D 2665) pipe specified in 7:9A-9.3(b)

Table 10. Narrative description of the Parameters

1. Durability

The Durability Index is a measure of how a product performs with respect to another product, or to a standard. If the comparison is to a standard product, in the rules, the evaluation would simply conclude a yes or no answer to the question (hypothesis) that Product A is as strong, corrosion resistant, or water tight , as Product B. If a standard exists like ASTM, then it can be used instead. This might be a case by case issue. The subclasses I believe are needed so far are:

- Durability Strength Index , DUR_S, Dimensionless , Boolean (Y,N)
- Durability Corrosion index , DUR_C, Dimensionless , Boolean (Y,N)
- Durability Water Tightness index , DUR_WT, Dimensionless , Boolean (Y,N)
- Durability Robustness index , DUR_R, Dimensionless , (ability to resist catastrophic failure)

4. Long Term Acceptance Rate Fraction or Soil Acceptance Rate (SAR), LTAR, Gallons/Ft2-day, Double precision. The effective permeability of a medium after a biomat forms which impedes flow. It is a function of intrinsic soil permeability as measured by permeability test or percolation tests. LTAR can be calculated as 5K - 1.2/log K (K=ft/min and LTAR =gallons/ft^2/day, or some other similar function (Arizona= $2/\sqrt{\text{perc\_rate(mpi)}}$. CORE may have to create a list of LTAR functions for the record.

5. Effective Leaching Area, ELA, Ft^2/Ft^2, Double precision

This is a measure of the actual surface area of a product available to emit wastewater. Connecticut regulations are the source of this concept.

6. Long term Acceptance Rate Multiplier, LTARX, dimensionless, Double precision. LTARX is derived from LTAR by employing the following function :

LTARX = (6.15*C^-0.3333-1.01)*S^1.28+1 where M= TSS +BOD (in mg/L).

7. Mechanical Complexity Index. Code = CMPLXTY. Dimensionless Classes, Integer (1,2 3)

This standard parameter is necessary to assess how complicated a system is, and to establish the need for particular levels of inspections, maintenance and management. At first cut, the following three criteria should work:

1. No moving parts
2. If moving parts fail, the system works equivalent to a conventional septic system
3. If moving parts fail, the system requires immediate maintenance, or it will result in a malfunction

17. Volumetric Acceptance Rate (VAR) is the actual amount of wastewater that can enter a porous medium in a given period of time, over a given area. It is derived by multiplying. VAR= LTAR * LTARX

Appendix 4: Application Form for Submitting to a Review Entity

Table 11. Application form

Name of Vendor	XYZ Corporation
Address of Vendor	Anytown USA
Review Entity	State of New Jersey
Product Name	XYZ Treatment Vessel
Product Class and Subclass	Pre-Treatment; Advanced Treatment Vessel
Verification Center	NJCAT

Appendix 5: Table of CORE Members

Table 12. Table of CORE Members

Member	Contact Person
New Jersey Department of Environmental Protection	Fred Bowers Fbowers@Dep.state.nj.us Phone: (609) 292-0407 Fax: 609-984-2147.
Pennsylvania Department of Environmental Protection	Susan Weaver 717-772-5636
Massachusetts Department of Environmental Protection	Marcia Sherman, Jim Murphy 617-292-5924
Illinois Department of Public Health 535 West Jefferson Street Springfield, Illinois 62761	Douglas Ebelherr Phone 217-782-4977 Fax 217-782-3987 TTY 800-547-0466
Contra Costa County General Environmental Health Programs Office Address: 2120 Diamond Blvd. #200 Concord, CA 94519	Ken Stuart, California Phone: (925) 646-5137 Office Fax: (925) 646-5225
Arizona Department of Environmental Quality, 3033 North Central Avenue, MO341A, Phoenix, Arizona 85012-2809.	Edwin K. Swanson Phone: 602-234-5677; Fax: 602-207-4528.
Oregon Dept. of Environmental Quality 811 SW Sixth Avenue Portland, OR 97204	Ed Woods Phone: 503-229-5415 ;FAX503-229-6037 woods.ed@deq.state.or.us www.deq.state.or.us

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Appendix 6: Table of CORE Certified Testing Centers

Table 13. Table of Potential CORE Certified Testing Centers

Testing Center	Contact Information	World Wide Web Address
NSF	NSF International PO Box 130140 Ann Arbor, MI 48113-0140, USA Telephone: (+1) 734-769-8010 Toll Free (USA): 800-NSF-MARK	http://www.nsf.org/

	Fax: (+1) 734-769-0109 E-mail: info@nsf.org	
NJCAT	New Jersey Corporation for Advanced Technology c/o Center for Environmental Engineering Stevens Institute of Technology Hoboken, NJ 07030 201-216-5326 - fax 201-216-8303 If you would like more information on NJCAT, please contact Ms. Rhea Weinberg Brekke, Executive Director, NJCAT at (609) 784-0023.	http://www.cee.stevens-tech.edu/NJCAT/
National Demonstration Projects	Associated with the National Small Flows Clearinghouse at West Virginia University.	http://www.estd.wvu.edu/nsfc/NSFC_NODP.html

Table 14. Form for listing claims and/or hypothesses to be tested during the IATV process.

Claim or Hypothesis	Summary of Method employed to verify the Claim	Relevant Parameters from Table 4
This product will achieve 14 mg/L Nitrate nitrogen		Nitrate Nitrogen

Appendix 7: Sample Letters

Application letter to CORE Members

Dear CORE members:

I have received an application to conduct an Innovative and alternative Technology Verification project from XYZ Corporation. I have attached a copy of the application form, and a copy of the proposal.

Please review the material and reply to me in writing by ____. Please indicate in your letter whether you agree with the proposal and whether you believe it represents a scientifically valid approach to evaluate the technology in accordance with the stated goals.

Sincerely,

Name of Domain Specific Review Entity Personnel

IATV Center Affidavit of Intent

I _____ certify that I have read and understood the approved IATV proposal Test Plan developed by _____ and that I shall follow the experimental design to the best of my ability. I will report all data accurately in accordance with the guidelines of the protocol entitled "A Protocol for Testing, Assessing and Approving Innovative or Alternative Onsite Wastewater Disposal Systems."

Signed:

Notarized:

Appendix 8
Example Outline of an Innovative and Alternative Technology Verification Program Proposal

I. General description of the technology
   A. Intended benefit
   B. Components
   C. Technology cost
   D. Regulatory challenges
   E. Existing approvals from other states
   F. Proprietary issues
II. Goals and objectives of the verification project
III. Experimental method to be employed in the verification program
   A. Collecting and maintaining descriptive data
      1. Systems and/or component plans and cross sections
      2. Site descriptions and maps
         A) a state map
         B) a topographic map(s):
         C) a ten mile radius map
         D) a topographic map
         E) a detailed site plan
      3. Soils data
         A) soil profile description
         B) soil chemical and physical properties
      4. Weather
   B. Collecting and maintaining experimental data
      1. Requirements applicable to all studies
         A) Maintaining an experimental log book
         B) Handling raw data
         C) Rendering data and deriving descriptive statistics
            (1) statistical analyses
         D) Additional performance evaluations
            (1) alarm systems
            (2) other
         E) Quality assurance / quality control (QA/QC)
            (1) QA/QC objectives
            (2) intended uses of acquired data
            (3) analytical quality levels and quality control levels
            (4) quality control indicators
            (5) precision
            (6) accuracy
            (7) representativeness
            (8) completeness
            (9) comparability
            (10) water quality and operational control checks
            (11) water quality data
            (12) spiked samples
            (13) method blanks

(14) travel blanks
(15) field duplicate samples
(16) performance evaluation samples
(17) quality control for equipment operation
(18) corrective actions

F) Maintaining weather and precipitation data

2. Requirements applicable to pretreatment system studies

A) Characterizing wastewater
B) Stress testing
C) Sampling requirements

(1) location
(2) frequency
(3) type
(4) sampling procedures
(5) sample collection procedures
(6) sample labeling and designation
(7) sample packing/shipping procedures
(8) sample chain of custody
(9) field records and documentation
(10) analytical procedures

3. Additional requirements applicable to conveyance accessory system studies

A) Evaluating durability
B) Evaluating capacity

4. Additional requirements applicable to final treatment component field studies

A) Monitoring the zone of treatment and zone of disposal

(1) Monitoring tools
(2) Parameter measurements

C. Use of existing data

IV. Site, operations, and maintenance considerations

A. General
B. Mechanical components
C. Electrical/instrumentation components
D. Chemical feed components
E. Other components
F. Byproducts or residuals
G. Level of operator skill and attention required
H. Electrical usage
I. Chemical usage
J. Environmental considerations

1. Noise
2. Odors
3. Waste management plan

V. The health and safety plan
VI. Warranty and maintenance requirements